REPORT OF AMERICAN ELECTROCHEMICAL SOCIETY MEETING

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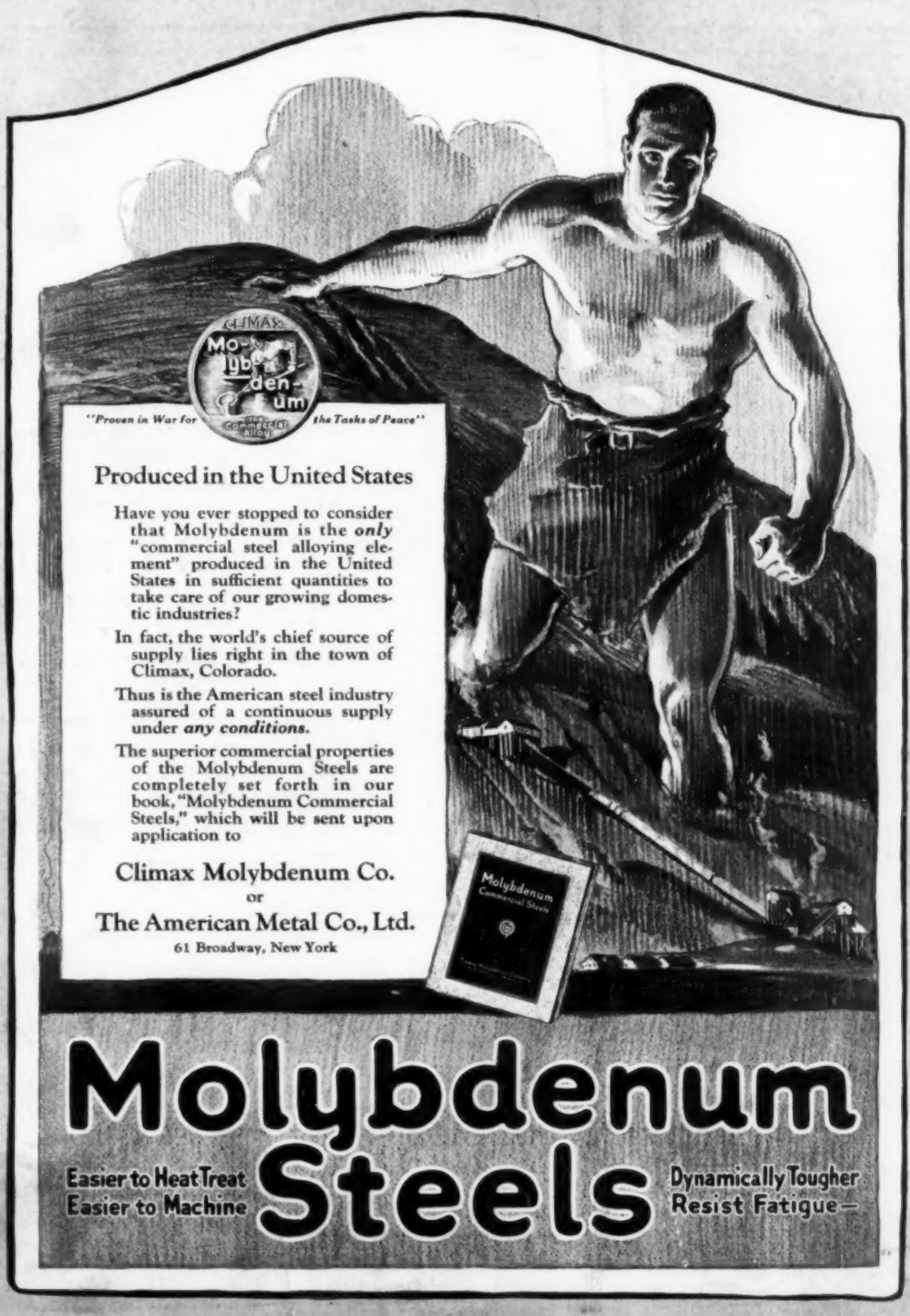
CHEMICAL & METALLURGICAL ENGINEERING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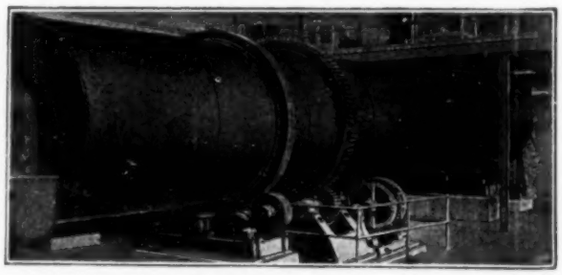

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Standard Samples To Continue

IT IS with great regret that we learned that the House of Representatives and the Senate both declined to grant to the Bureau of Standards continuance of the fund for the preparation and distribution of standard samples. This small sum, amounting to $5,000 a year, was, as we have previously pointed out, really self-supporting, as the cash income from the work was more than $6,000 during the last fiscal year. In fact, credits for work done for state and Federal departments brought the total book value of the income up to over $10,000.

Despite this interruption of the appropriation, it has been decided by the Bureau of Standards to continue, at least in part, the standard sample work, and we congratulate that institution on this decision, even though we realize it had to be made with the understanding that certain other work would suffer correspondingly because of this burden being absorbed by the regular funds of the Bureau. In return for this self-sacrificing decision, the industries and our educational institutions owe a debt to the Bureau of Standards which should be recognized and met. Our metallurgical industries should in every way possible co-operate with the Bureau in securing the necessary irons, steels, brasses and other materials at a nominal expense to it, thus reducing the cost of preparation of the samples to a very minimum. The educational institutions should also co-operate by a very sparing use of the materials, refraining altogether from their use in student work except for purposes of research or in work of an advanced nature.

The cost and difficulty of preparing standard metal samples are little appreciated by those who have not given thought to this matter. It is an easy thing to ruin a sample of many hundred pounds after weeks of careful work had been put on it if for any reason a portion of it comes to have a slightly different composition than any other part of the mass. Very few institutions have either the facilities or the skill required for the painstaking work of this preparation. It is really a serious matter, therefore, when material prepared at great expense of time and skill is used unnecessarily by instructors as student samples. The Bureau quite properly declines to supply materials for such use when it has knowledge of the circumstances. It is suspected, however, that much use is being made of the materials without the knowledge of the Bureau, we would urge any who have unwittingly done this to discontinue such practice.

We trust that by another year Congress will come to appreciate the great importance and value of this activity and will appropriate for its continued growth in a measure commensurate with its work.

Iron Castings in Iron Molds

EVERY so often the question pops up, "Why are not permanent molds more widely used for iron castings?" The questioner may have in mind the great success of die casting as applied to white metal alloys or more recently to the more difficult aluminum bronzes; or he may have a recollection of having heard that such a procedure has been or could be applied to the iron foundry.

Perhaps the usual answer if the question were put to the "old-timer" would be that chill castings would have a heavy skin of white iron and the machine shop could do nothing with them. The answer would be entirely correct, and could be substantiated at any time by pouring a little of the iron regularly coming from the cupola and destined for green sand into a pig mold. The depth of the white-iron shell might even be intensified by filling a heavy deep iron cup. Examination of this sample when fractured would immediately show whether there was any possibility of a die-cast piece being machinable, a test used by OUTERBRIDGE for over thirty years. He it was who discovered and put to thorough commercial application a long time ago the fact that if the metal possessed the correct composition, either by original melting or by ladle additions of ferromanganese and ferrosilicon, such a chill cup would not produce even the thinnest skin of white iron, and a properly designed mold would give a commercial casting, soft and strong, very fine grained, almost steel-like in appearance after machining, yet having practically no combined carbon at all. He first set chill blocks in sand molded gear wheels, so that the rate of solidification could be so controlled that an accumulation of deep-seated cavities would not appear at the arm-junctions. From that point, progress naturally suggested a like practice on lathe beds, where dense sound iron is requisite.

If correct iron could cool against a series of blocks set in supporting sand without developing hard spots in the casting, there seemed no reason why the entire mold should not be made of iron, even to any necessary cores.

OUTERBRIDGE did it, and has made over a million castings in iron molds, machinable castings of exceedingly fine grain, free of dirt, sponginess and other defects, and having a marked increase in strength over the sand-cast metal. In this work the cores were withdrawn quickly to prevent seizure, but the casting cooled black in the mold.

This work at the Sellers foundry was kept a close secret for many years, with only bits of information leaking out from time to time. Therefore later work was along independent lines and without advantage of the accumulated experience at this particular foundry.

As an instance, CUSTER designed die-casting machines for soil-pipe fittings, which operated commercially for some time. This was before the days when the widespread introduction of molding machines had so largely reduced the labor expense on sand molds, and correspondingly dulled the spur to reduce molders' labor to the extreme minimum. Instead of using his molds once a day, CUSTER held the hot iron in the mold but a minimum of time necessary to maintain its form, when the cores were withdrawn, the mold opened, and the hot casting cooled in air. In this manner a single mold, operated by hydraulic power, could produce a hundred castings or more every shift. Such casting practice apparently allows a much wider range of chemical composition in the fluid iron than the Sellers method, since any cementite forming at the quick-solidifying surfaces is annealed into ferrite and temper carbon during subsequent slow cooling.

As is the case for die castings for white metal, such permanent molds are quite expensive to design and construct, much care being necessary to provide properly for gates, vents and traps. Unfortunately the molds, and especially the cores, are short lived. They ordinarily fail by surface disintegration, showing as a swelling, cracking and spongy layer of variable depth, which causes difficulty in shaking out the casting and ruins its surface appearance. This deterioration in the mold is caused by the well-known property which cast iron has of growing when heated repeatedly to redness. Yet so little known and so little under control is this fundamental property of the permanent mold that one metallurgist recommends the use of low-silicon white iron, which has less than the ordinary amount of growth, for molds which should never be brought in any part to a visible heat, while another experienced in bronze die-castings, whose working temperatures are comparable to that of iron, recommends the use of a close-grained iron with low combined carbon—a combination which is hard to get except by chilling high-silicon iron.

In the light of current literature and common information, the subject of iron castings in permanent molds offers an attractive field for experimentation and profitable application, either along the lines of casting in dies, with or without extraneous pressure, and with sand or metal cores, or of casting cylindrical pieces in centrifugal machines without molds, gates or risers of any kind.

How little it is applied today may be inferred from the fact that a large foundry producing 1,000 tons of automobile engine-parts every day makes but one part in permanent molds, and that in a centrifugal machine. At that its practice is to remove the castings, and cool in mica or ashes, and even this fails at times to produce machinable rings.

Even with all this in mind, one feels justified in saying that certain castings requiring a very fine grain, and uniform texture; free from blow holes, shrink holes and pipe; high strength and practically no combined carbon can be turned out in large quantity with a minimum molding expense in permanent molds in a manner unapproachable by any other known method. When this fact is widely known, the method itself will be intensively studied and widely applied by the largely increasing numbers of inquisitive metallurgists now questioning the sacred traditions of the iron foundry. Only men of this type would attempt what seems so bizarre, and almost foolish.

Research and Imitation Research

IN THE years past the fundamental schooling for industrial achievements was apprenticeship. The "old-timers" instructed the novices in the intricacies of the trade, which were considered as secrets to be revealed only to the apprentice. The guilds of the different industrial arts were comparable in a way with the unions of to-day, with the distinction that the former were solely protectors of the trade, while the latter are concerned chiefly with the problem of fixing higher monetary compensation for their members. The question of sound industrial progress through systematic technical improvement has received but scant attention by such organizations of workers.

It is only in recent years that systematic research work has been undertaken in order to further the progress of practically all branches of technical art; but, like any other innovation, it is liable to trespass the limits of actual usefulness, drift into mere duplication of effort or produce results hastily accepted as improvements at the cost of great expenditures in time and money.

The technical school of to-day feels that it can no longer confine its attention to an academic presentation of the theoretical intricacies of a particular subject; it must combine theory with as many practical applications as possible, with research work as the finishing touch for the technical graduate. Competition among the various schools has resulted in the establishment of research laboratories and courses in research at substantially all of the American technical institutions, and even as separate departments of the graduate school in the universities. Research work is very expensive, and the question arises as to whether the funds thus used might not have been applied in many cases to better advantage—in improving the salaries of the teaching staff, for example.

In the recently published report of the Carnegie Foundation for the Advancement of Teaching, the president, Dr. HENRY SMITH PRITCHETT, says:

"Much of that which has gone on in American universities under the name of research is in truth only an imitation of research and upon it great sums have been expended. College salaries also have been diluted enormously by the tendency of most college faculties and governing bodies to bid for students by extending the curriculum over the whole field of knowledge, a process which means great increase in the number of teachers and the consequent leveling down of salaries."

The need for productive research in pure and applied science is urgent, but we must not lose sight of the fact that not all students are endowed with the temperamental prerequisites of the research worker. On the other hand, industry must have technically trained men who are able to interpret and apply the results of research in the plant. Dr. PRITCHETT suggests that the universities take stock of themselves and "render a sincere and critical statement of the results obtained in education by the expenditures of the last twenty-five years." Is it not possible that such introspection would reveal the fact that we have placed too much stress upon the mere formalities of the "research course," without careful consideration of the needs of science and industry, the potentialities of the graduate student entering such work, and the capabilities of the faculty nominally in direction?

Alive to The Situation!

AMERICANS like to tell themselves and advertise to strangers that we are the most progressive, the most far-seeing and the most everything else you want to mention. That is to say, a certain egotistical minority do the advertising, and the rest of us believe we can see an ell, at least.

Yet nine out of ten of us cannot see an obvious event until it knocks us down and runs over us, despite the unheeded warnings of the active publicist or propagandist. We pay no attention to him because we don't trust him; because we feel there must be a sinister hidden influence somewhere; because we think he is trying to use us for the profit of himself or his applications; or because he is labeled as a plain crank.

So it is that nearly everyone buys on a rising market, few build when prices are low, and improvements in technology are left for the other fellow to develop. Nor will we give heed to plain economic tendencies until it is almost too late.

Picture the anguished consternation of the well-to-do professional man who has never been seriously inconvenienced by labor troubles finding that there are no accustomed trains to carry him the intervening miles from his home to his work. Labor troubles before have been impersonal things, perhaps inconveniencing the other fellow a bit and maybe slightly reflected in inflated prices. "But here! No trains! Is it possible that a few railroad switchmen have the whole country by the throat? Can a few bolsheviks hold up the nation and rob it with impunity? Somebody ought to be lined up against the wall and shot! Outrageous!"

All because the 8.17 is not running!

Steel Prices And Other Prices

WHEN during the war the Government began fixing prices it was held that a new system was inaugurated, that previously prices had been fixed in but one way, by "the law of supply and demand," except when the wicked trusts got in their work. Government price control ended, generally speaking, at the close of 1918, a few weeks after the Armistice, and an effort in the following March to regulate prices under Government auspices failed for a variety of reasons. Are prices now fixed by the law of supply and demand? One can hardly maintain that they are.

To point out proofs that prices are not now fixed by the law of supply and demand, however, is to develop some arguments that could have been used before the war to show that even then prices were not set by the "law" of supply and demand, which would make it appear that it isn't a law after all, but something cognate rather to a motto, a motto being something that one follows, if at all, only at his convenience.

For supply and demand to set prices would really mean in substance that the material to be sold is auctioned off day after day to the highest bidders, and that hardly occurs. It seems curious that we should have been talking so much about the law of supply and demand when so little evidence could be found of its actually being the controlling influence. One reason can be vouchsafed, that it represents the continuance of an idea after the circumstances that created it have disappeared in very considerable part. Imagine all products made by individuals, each man being his own manufacturing concern, with practically no capital investment in factory or materials, and a good many of the men jack of all trades so that they can shift from one class of goods to another. Then if the demand for gloves decreases the price falls until some of the men turn to making shoes, for which satisfactory prices are obtainable. The decline in gloves is arrested before anybody starves through inability to make enough gloves per day, at the low price prevailing, to buy him his bread and butter.

With the factory system this regulation cannot occur, and the factory system has been growing up for decades. If it does not hamper the operation of the old law of supply and demand, which would work in conditions like those just imagined, it at any rate would make a very unfortunate situation at times. This, indeed, it has done, and the fact that there have not been glaring cases in recent years does not indicate that experiences of the more distant past cannot be repeated, and on a larger scale. Those who lived through the industrial depression of 1893 to 1898 can readily recall the term so common then, "bankrupt competition." Numerous manufacturing concerns failed. Some of them had been promoted by country towns by a cash bonus, free land and exemption from taxation for a period of years. The promoter came along, was given possession of the factory merely in return for his promise that he would operate it and, presto, there was a manufacturer whose cost sheet had no blanks to fill in for amortization, obsolescence, depreciation, taxes or interest on investment. Respectable and responsible manufacturers, producing the same class of goods, paying taxes, conducting a legitimate business and entitled to thrive, were exposed to this "bankrupt competition."

Prior to the war competition was a factor in influencing commodity prices, and there was also the influence of manufacturers and sellers generally feeling that if they embraced an opportunity to make inordinate profits, when presented, retribution would likely come some time.

Selling prices now are made largely by what manufacturers think it right and proper to charge, and as there is a wide diversity of opinion among sellers, there is also a wide diversity of prices. In the steel industry, for instance, there is the United States Steel Corporation, which makes about 44 per cent of all the country's steel products, sedulously adhering to a certain schedule of prices, which chances to be the Industrial Board schedule that became effective March 21, 1919, and the independents all asking and securing higher prices, in some cases by half a cent a pound, in other cases by three or four cents a pound. If this were the result of the operation of any law of supply and demand, the Steel Corporation's products would be proved to be sonimous (word coined by CHARLEY SCHWAB) beyond ordinary powers of conception. Go into a hardware store, make a collection of tools all made of much the same material, brass, steel, etc., and by quite the same classes of workmen, and inquire how present prices compare with those of 1915. Some of those tools will be found to have advanced two or three times as much as others. That is the difference in the psychology of the makers, not any difference in the cost of the raw materials and labor.

Readers' Views and Comments

Mineral Resources and Chemical Industries of the Southern States

To the Editor of Chemical & Metallurgical Engineering

SIR:—The writer has read with much interest the article by Andrew M. Fairlie on "Some Developed Mineral Resources and Chemical Industries of the Southern States," in your issue of Feb. 18. Considerable attention is there devoted to the Southern phosphate fields which are now developed. It is the purpose of this communication to call attention to an as yet undeveloped phosphate deposit in the Southern States which is of peculiar interest.

I refer to the dahllite and collophanite found along the junction of the shaly limestone and Watanga shale in Johnson County, east Tennessee. This deposit was just noticed in 1915, when the Tennessee State Geological Survey made as detailed a report as the undeveloped condition of the field would permit. Such work as has been carried out up to the present time shows the presence of considerable amounts of phosphatic material containing 60 to 75 per cent tricalcium phosphate, as well as very large amounts of rock which is of a lower grade.

The economic importance of this bed is not so much as a source of phosphorus *per se*, but more especially its proximity to coal, coke, sulphuric acid and silica. Conditions are peculiarly favorable for the putting of this material into marketable form either as fertilizer or as elemental phosphorus. STUART W. MAHER.

Kingsport, Tenn.

The History of Mustard Gas

To the Editor of Chemical & Metallurgical Engineering

SIR:—In reference to the recent article on the History of Mustard Gas by Clarence J. West in your issue of March 24, 1920, Mr. West, as well as the authors of the controversy as to the discovery and commercial development of the reaction between ethylene and sulphur chloride, seems to have lost view of two extremely important points. One is that whatever the merits of the inventors and of the authors of the very large program of mustard gas to be manufactured (for home consumption, for it never reached the enemy), the only one of the Allies that manufactured and fired mustard gas was the French, and the other point is that whatever the merits of the Levinstein process the sulphur dichloride process furnished practically the whole of the mustard gas that was ever used against the Germans.

To be sure, this should not detract in any way from the merits of the Levinstein process, which doubtless would have become universal had the war lasted much longer, but, since the article purports to be a historical article, it should certainly mention that as a historical fact the sulphur dichloride process was the only one which was actually producing on a large scale in time to allow its product to be used against the enemy. In a series of confidential reports which I made to the Chemical Warfare Service I followed from February, 1918, until the armistice the progress which was being made by the plant of the Société Chimique des Usines du Rhone.

This plant started early in March with a production of two to three tons a day and was in July producing close to twenty tons a day. It was being duplicated at the time of the armistice, so that probably by December, 1918, the production of mustard gas by the dichloride process would have reached about forty tons. Early in June the first consignment of shells filled with mustard gas reached the French front and I believe about June 18 the first mustard gas shoot conducted by any of the Allies was carried out by the French.

I had occasion to mention this fact before at a meeting of the Société de Chimie Industrielle, an account of which was published in your journal[1], but evidently it seems to have escaped Mr. West's attention as well as, which is more inexplicable, the numerous reports to which Mr. West had access during his long and successful connection with the Chemical Warfare Service.

Mr. West's remarks regarding the sulphur dichloride process create the impression that it was never successfully worked even in the laboratory, when, as a matter of fact, it was practically the *only* process that was working in time to be of military use, the mustard gas made by other methods in France amounting then to only a few tons.

I hold no brief for the dichloride process. Besides the complicated and costly apparatus, it required considerable quantities of carbon tetrachloride, a solvent which was very scarce during the war, but when the matter is looked at historically the fact remains that it was the only one which was developed and running on an industrial scale when all others had just graduated from the laboratory or barely entered the semi-industrial stage. J. E. ZANETTI.

Columbia University,
New York City.

Need of Co-operative Educational Work in the Chemical Industry

To the Editor of Chemical & Metallurgical Engineering

SIR:—The reference to the American Cranberry Exchange, on page 511 of your issue of March 17, recalls a story which may or may not be familiar to the cranberry men, but which seems at any rate to have some advertising value.

A native of Cape Cod, in the course of conversations with an old French chef, happened to mention the cranberry. "Ah, ze crranberry," said the chef, "I know ze crranberry; you take heem and you stew heem, an' he make ze better apple sauce zan ze prune do."

If our cranberry-growing friends wish to make use of the story in advertising their product, I will cheerfully waive all proprietary rights.

FREEMAN F. BURR,
Geologist.

Augusta, Me.

[1] CHEM. & MET. ENG., vol. 21, No. 10, Oct. 22, 1919, p. 533.

CHARLES RIVER SKYLINE OF BOSTON

Boston Meeting of the American Electrochemical Society

Symposium on Colloids—Joint Meeting With the American Institute of Electrical Engineers—Discussion on Ferro-Alloys and Power for Electrochemical Industries—The Electric Brass Furnace

THE thirty-seventh general meeting of the American Electrochemical Society was held in Boston, April 8 to 11. In spite of unsettled business conditions, difficulties in traveling and lack of ample hotel accommodations, the meeting was one of the best attended for many years. There were over 300 members and guests registered. Animated and stimulated discussions of the pre-war type prevailed; these were characterized by the open-minded attitude of former days, which of necessity had dwindled during the war. Among the social features, the big Little smoker will linger long in the memories of all.

Meeting of the Board of Directors

At the meeting of the board of directors the treasurer's annual report was submitted. The liquid assets of the Society aggregate $17,000. The membership committee, C. G. Schluederberg, chairman, reported a present total of 2,307 members, as compared with 1,903 members on Jan. 1, 1919. Among the new business transacted, it was moved to circularize the membership and ascertain the opinion of the individual on the general adoption of the metric system in this country. President Bancroft appointed Messrs. Landis, Richards, Lash, Miller, Chaney and Tucker a committee of five to consider carefully the various proposals for the next meeting place of the Society and to report to the board not later than May.

Officers Elected at Annual Business Meeting

The annual business meeting was held in Huntington Hall. Upon the report of the tellers, the following officers were declared elected: President, W. S. Landis: vice-presidents, J. A. Mathews, L. E. Saunders and A. T. Hinckley; managers, Colin G. Fink, Acheson Smith and H. B. Coho; treasurer, Pedro G. Salom; secretary, Joseph W. Richards.

Technical Session—Thursday Morning

Prof. Henry P. Talbot of the Massachusetts Institute of Technology welcomed the members of the Society and dwelt briefly upon the ever-increasing importance of electrochemistry. The war has demonstrated most emphatically that "the ultimate defense of our country lies in the hands of electrochemistry."

The presidential address of the retiring president, Wilder D. Bancroft, dealt with the present aspects of contact catalysis theory. The action of infra-red radiation was discussed at length and the conclusion drawn was that until some proof is brought that a contact catalytic agent can act at a distance, we are justified in postulating that the reaction takes place in or at the surface. A corollary from this is that any substance which cuts down the rate at which the reacting substances reach the catalytic surface, or which prevents them from reaching it, will decrease the reaction velocity, and may destroy the catalytic action entirely.

The piling up of the reaction products will cut down the reaction velocity, if they prevent the reacting substances from coming in contact with the catalytic agent. This has been observed in the contact sulphuric acid process, where sulphur trioxide inhibits the reaction by sealing off the reacting SO_2 and O_2 from the platinum sponge.

Since reaction velocity is probably directly propor-

tional to the difference of chemical potential and inversely proportional to the chemical resistance, we can increase the reaction velocity either by increasing the difference of chemical potential or by decreasing the chemical resistance. When the reacting substances are adsorbed at the surface of a catalytic agent, there is a marked increase in the concentration and it has been suggested that this is the cause of catalytic action. As a matter of fact, the effect of concentration seems to be relatively unimportant in most of the cases studied hitherto. It is stated that oxyhydrogen gas has been found to be quite stable under pressures of 2,000 atm., which shows that the catalytic action of platinum on mixtures of hydrogen and oxygen must be due to something more than a change in concentration.

If we have selective adsorption of the reaction products, this will cause a lowering of the chemical potential of the resultants and will therefore increase the reaction velocity. It may even determine the direction of the reaction. Alcohol breaks down into acetaldehyde and hydrogen in presence of pulverulent nickel and into ethylene and water in presence of pulverulent alumina. Since nickel adsorbs hydrogen strongly and alumina adsorbs water, it seems natural to assume that the selective adsorption is the determining factor. However, this conclusion does not work well with the fact that the latter reaction is very much facilitated by the addition of steam.

If changes in the chemical potential are not the important factors in contact catalysis, the catalytic agent must change the chemical resistance in some way. There are two possible means for this, either more effective collisions between the reacting molecules or conversion of the reactive substances into an active form. While the conversion of a reacting substance into an active form may very well account for the effect of the solvent on reaction velocity in homogeneous systems, it must be shown what active form is produced and why one solvent produces more of it than another.

In conclusion, Prof. BANCROFT stated the study of organic reactions is by far the most likely to prove fruitful, and he listed tentatively sixteen problems which should be investigated.

Symposium on Colloid Chemistry

Dr. BANCROFT opened the quartet of papers discussing colloid chemistry with a résumé of phenomena having an electrotechnical aspect. So long as the suspended particles are all charged positively or negatively, they will tend to repel one another and will not coalesce unless the concentration is too high. Colloid solutions will be very sensitive to electrolytes having a readily adsorbable ion of the opposite charge from that which stabilizes the colloids. The formation of deltas is due primarily to the coagulation of the suspension by the electrolytes in the salt water. Migration of colloidal particles under electrochemical potential, cataphoresis and electrical endosmose, the functioning of a diaphragm, were discussed. Charged dust suspensions and their electrostatic precipitation were described in analogy to liquid suspensions.

Settling Problems

WILLARD A. DEANE, of the Dorr Co., spoke at length on "Settling Problems" and how these have been successfully solved.

The introduction of "continuous settling" has resulted in greatly increased application of sedimentation processes. The practical requirement of every settling problem involves two distinct processes, one clarification, the other thickening. The requirements for clarification are the minimum thickener area permissible with a continuous overflow of liquid of specified clarity. The requirements for thickening are a continuous discharge of thickened pulp of lowest permissible moisture content. In clarification problems the settlement of the finest particles is the governing feature. The settling properties of a pulp may be largely improved by a proper adjustment of conditions in processes prior to sedimentation.

Each settling problem is governed by specific conditions requiring independent study and analysis, and the most satisfactory solution often involves a study of processes and methods with a view of possible changes in certain conditions, so as to alter the physical character of the suspension and promote improved settling.

In the discussion of Mr. Deane's paper, the Chair, Dr. BANCROFT, called attention in particular to the author's description of the clarification of concentrated solutions. Deane's is the first good explanation he had seen to account for the fact that dilute solutions settle cloudy and thick or concentrated solutions clear. There is a sort of filtering effect taking place in the latter solutions, the coarser particles holding up the very fine ones. In the separation of cream from milk we have an upward filtering motion; and in a deep pan cream separates faster than in a shallow one.

Graphitic Acid—A Colloidal Oxide of Carbon

The third paper of the symposium was submitted by GEORGE A. HULETT and O. A. NELSON, of Princeton University, on "Graphitic Acid—A Colloidal Oxide of Carbon." After a careful survey of the investigations on graphitic acid carried out in the past, the authors reported on a series of experiments made to determine the relations of water to graphitic acid.

The translucent graphitic acid plates are made of an infinity of plates of excessive thinness. The relation of water to this substance and its variable properties are readily interpreted on the assumption that graphitic acid is a solid oxide of carbon with an exceptionally large surface covered with adsorbed water. The information available indicates formulas of the order C_3O or $C_{11}O_4$.

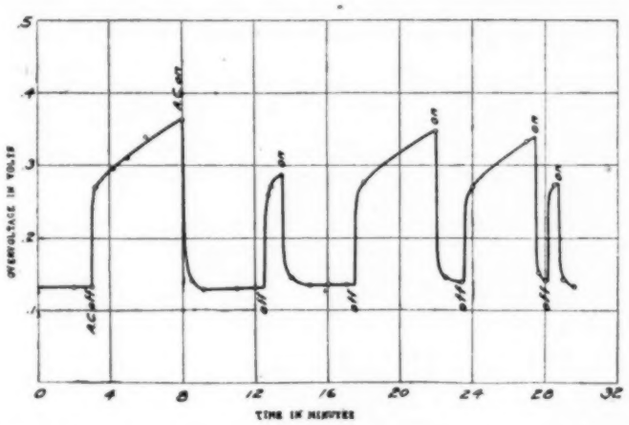
In discussing this paper, F. A. J. FITZGERALD referred to his years of investigation of a method of analysis for graphitic oxide without obtaining any positive results. He had made the best graphitic oxide from a sample lot of Irish coal; this oxide would swell up very appreciably during graphitization in the electric furnace. E. O. BENJAMIN called attention to the fluffy graphite that Mr. AYLESWORTH of the Edison Co. had obtained. The volume was about seven times that of any other graphite.

Problem of Determining Graphitic Carbon

W. A. SELVIG and W. C. RATLIFF, of the Bureau of Mines, Pittsburgh, Pa., reported upon a detailed investigation of the Problem of Determining Graphitic Carbon. No direct quantitative method for the determination of graphitic carbon in the presence of amorphous carbon has ever been developed before. Selvig and Ratliff tried out the Brodie and Staudenmaier methods ($H_2SO_4 + HNO_3 + KClO_3$) for the conversion of gra-

phitic carbon to graphitic acid on Alabama, Pennsylvania, Ceylon and Acheson graphites, and on mixtures of Ceylon and Acheson graphites with amorphous carbon in the form of anthracite and bituminous coal and coke. The Staudenmaier method (14 c.c. concentrated H_2SO_4, 6 c.c. concentrated HNO_3 and 18 g. $KClO_3$) was not applicable to substances containing relatively large amounts of amorphous carbon, as the reaction goes to explosive violence. Amorphous carbon in the form of anthracite and bituminous coal and coke when treated by the Brodie method (10 c.c. HNO_3 + 4 g. $KClO_3$ per ½ g. of sample) gave no graphitic acid in the case of the anthracite and bituminous coal. A slight amount of graphitic acid was, however, obtained from coke, this indicating the presence of graphitic carbon in coke. Graphitic acid cannot be made to come to constant weight by ordinary methods of drying, as the substance is very susceptible to varying humidity changes.

The Brodie method of conversion of graphite to graphitic acid can be hastened by a supplementary treatment with sulphuric acid and potassium permanganate. Carbon in the form of coal, coke, calcined anthracite,



SHOWING TYPICAL EFFECT OF ALTERNATING CURRENT ON OVERVOLTAGE

natural and artificial graphites gave varying amounts of CO_2 when treated with the Brodie mixture.

The graphitic carbon content as determined by conversion to graphitic acid by the Brodie and Staudenmaier methods and subsequent combustion gave low results as compared to direct combustion of the graphites. These differences were the least in the Ceylon and Acheson graphites and greatest in the Alabama and Pennsylvania graphites. They may be due to the differences in the physical characteristics of the graphites, such as flake structure. However, no satisfactory reason can be given why, when subjected to the same number of treatments with the same oxidizing mixture, Alabama and Pennsylvania graphites give a larger loss of carbon as CO_2 than do Ceylon and Acheson graphites.

Graphitic acid when treated with the Brodie mixture slowly gives off CO_2. It appears that when graphitic carbon is treated with oxidizing mixtures a series of oxidation products result, the end products being CO and CO_2. The maximum yield of graphitic acid is obtained under rather narrow limits as to temperature, time, and oxidizing reagents.

With Ceylon and Acheson graphite, in which the conversion of the graphitic carbon to graphitic acid proceeds at a comparatively rapid rate, the graphitic carbon content as estimated by the Brodie and Staudenmaier methods gave results which were within 5 per cent of the true graphitic carbon content. On the other hand, Alabama and Pennsylvania graphites, which required a prolonged treatment for conversion into graphitic acid, gave very low results, due, no doubt, to a larger loss of carbon as carbon gases resulting from complete oxidation to CO and CO_2. Carbon in the form of coke and partly calcined anthracite coal, though finely ground, required more treatments than pure graphitic carbon in the form of Ceylon and Acheson graphites.

The action of oxidizing mixtures on different forms of carbon offers an extended field for further scientific investigation.

In the discussion, Mr. FITZGERALD suggested that the methods as outlined by the authors might be applied to advantage to the different grades of carbon and graphite anodes on the market today.

Overvoltage—Dry Cells—Storage Battery

"The Effect of an Alternating Current on Hydrogen Overvoltage" was the title of a paper by H. M. GOODWIN and M. KNOBEL, of the Massachusetts Institute of Technology. They studied the overvoltage of hydrogen on platinum, lead and copper cathodes when alternating current was superposed on the direct electrolyzing current. The effect of varying the alternating current was also studied, the effect of its frequency and the power factor. The effects seem in general to be due to the oxygen liberated on the cathode by the reverse wave of the alternating current. The magnitude of this depolarization appears to be independent of the electrodes and of the current density, and determined primarily by the ratio of alternating to direct current used. The effect increases slightly as the frequency decreases, but results would indicate that it is practically independent of the power factor.

H. D. HOLLER and L. M. RITCHIE reported their observation of a marked difference in potential of manganese dioxide electrodes made of natural ores and the chemically prepared oxide, the former giving twice the voltage and varying as a logarithmic function of the hydrogen ion concentration. The prepared oxide showed no relation to the hydrogen ion concentration. The cause of this difference has not been investigated. At least a portion of the polarization of a dry cell during discharge may be explained as being due to a layer of electrolyte on the surface of the electrode impoverished in hydrogen ions.

A careful investigation of "The Reactions of the Lead Accumulator" was reported upon by Prof. D. A. MACINNES. The research was carried out by himself and L. Adler and D. B. Joubert at the Massachusetts Institute of Technology and the University of Illinois. The amount of sulphuric acid consumed during the discharge of a lead accumulator was measured in order to determine whether 2 or 1 g. equivalents of acid disappear per Faraday passing and in order to decide between Gladston and Tribe's formula for the chemical reaction or that advanced by Fèry. The result was intermediate of the two. Careful chemical analyses of the oxide formed during charging show it to be certainly PbO_2. The chemical potential of the oxide on the positive plate was also found identical with that of chemically prepared PbO_2 and electrically precipitated PbO_2. The author suggested tentatively that intermediate oxides, for example Pb_3O_4, or basic compounds, for example $(PbO)_4.PbSO_4$ may be formed during discharge.

Arc Images in Chemical Analysis

The final paper of the Thursday morning session was that of William Roy Mott on "Arc Images in Chemical Analysis." Mr. Mott has been conducting a long series of highly interesting tests at the laboratories of the National Carbon Co.

Mr. Mott reproduced upon the screen some of the most characteristic arc images.

Dr. Bancroft, in discussion, complimented the author and ventured to say that the day was not far off when all analytical laboratories would be equipped with an arc image-testing outfit. Dr. Fink referred to the fractional separation of rare earths by the arc process and the comparative simplicity of this process as against any of the wet processes. Letters of commendation were received from Prof. Leonard of Wisconsin and Dr. Hillebrand of Washington.

Thursday Afternoon at Cambridge

Luncheon was served at the Walker Memorial Building of Massachusetts Institute of Technology, Cambridge, and an opportunity was afforded the members to inspect the splendid new buildings.

A New Cyanide

A technical session was held at the Institute from 2 to 4:30. The first paper was that of the incoming president, W. S. Landis, on "A New Cyanide" (see Chemical & Metallurgical Engineering, vol. 22, No. 6, Feb. 11, 1920, p. 265).

In discussion, L. E. Saunders of the Norton Co. gave a brief account of his early experiments on cyanamide and cyanide carried out in the electric furnace. With barium salts he had obtained fairly high efficiencies. The barium cyanide-cyanamide mixture was fused together with soda ash; the output of NaCN was high enough to offer commercial possibilities, but basic patents interfered.

Carbon in Iron

Dr. T. D. Yensen, of the Westinghouse Research Laboratory, presented a paper on a highly efficient method of determining very small amounts of carbon in iron.

The ordinary method of determining carbon in iron and steel consists in burning the sample with free oxygen, absorbing the CO_2 by means of KOH and weighing the KOH bulb before and after. In order to eliminate the errors due to absorption and weighing, the new method substitutes freezing out the CO_2 with liquid air and allowing it to expand into a known volume and noting the increase in pressure. In order to differentiate between the carbon existing as adsorbed CO or CO_2 and that existing in combined form, the method involves two heatings, one to 600 deg. C. in vacuo, and the other to 1,000 deg. or higher in oxygen. Extra precautions are also taken to eliminate errors due to other sources, so that by this method carbon can, if necessary, be determined with an accuracy of ± 0.0001 per cent.

Dr. Yensen's vacuum method gave rise to much favorable comment and was generally conceded to be one of the greatest advances in carbon analysis. Dr. A. S. Cushman of Washington pointed out that one of the great advantages of the Yensen method lay in the fact that we could now readily determine separately the three kinds of gases present in iron and steel: (1) blow-hole gas; (2) gas held in solid solution, and (3) "combined" gas, i.e., nitrides, carbonyls, carbides, etc. Nitrogen has a very deleterious effect on the quality of the steel; and furthermore, the effect of nitride nitrogen is distinct from that of dissolved nitrogen.

Other papers presented during this session included "The Influence of Enclosed Slag on the Corrosion of Wrought Iron," by L. T. Richardson, and "The Embrittling Effects of Cleaning and Pickling Upon Carbon Steels," by S. C. Langdon and M. A. Grossman, abstracts of which will be published in subsequent issues of Chemical & Metallurgical Engineering.

Electrolytic Calcium—Chromium—Bronze

P. H. Brace, of the Westinghouse Co., submitted an account of experiments on "The Electrolytic Production of Calcium," in which a new modification of Goodwin's moving-cathode cell was developed. Pure calcium chloride, properly dehydrated, was found to be the most satisfactory electrolyte. The product contained 1.08 per cent of chlorine and very small quantities of carbon.

"Electrolytic Chromium" was the title of a highly interesting paper contributed by George J. Sargent, of New York.

Brief allusion was made to the history of the deposition of chromium, including some unpublished work done by Skillman at Cornell University. Details were given of the electrolysis of various mixtures of chromic sulphate and chromic acid, showing that the yield of chromium from chromic acid solutions is greatly increased by the addition of chromic sulphate. Tabulated records were included of experiments with rotating cathodes, as compared with stationary cathodes, and investigations of the most favorable temperatures, and strengths of solution and mixtures, and current densities. Some theorizing was indulged in concerning the deposition of chromium with two different valences, 3 and 6, from chromic acid, chromic sulphate plating solutions. Very good deposits of chromium were obtained from chromic acid solutions containing small amounts of chromic sulphate. Low temperatures yielded fair ampere-hour efficiencies at comparatively low current densities. A deposit up to 1.25 cm. thick was obtained. The chromium plating is extremely resistant to corrosion by air, moisture, and many chemicals.

During the discussion of the paper, Dr Bancroft, under whose direction the research had been carried out, emphasized that the quality of the chromium deposit was very much dependent upon the current density. Attempts were made to produce a chrome-steel surface on iron by heating the plated iron in hydrogen. But very high temperatures were required to bring about good alloying and the scheme did not prove to be practical. F. S. Weiser, of Waterbury, suggested that a chromium-plated nickel wire might be used in place of the nickel-chromium alloys.

"Bronze Plating" was investigated and reported upon by Prof. F. C. Mathers and Stanley Sowder, a student of his at Indiana University. They found that bronze can be deposited from a bath containing potassium hydroxide 5 per cent, potassium cyanide 0.5 per cent, ammonium stannic chloride 0.38 per cent and potassium copper cyanide 1.5 per cent. Satisfactory corrosion of bronze anodes is obtained, using a temperature of 40 to 50 deg. C., and current density of 0.4 amp. per sq.dm. (3.75 amp. per sq.ft.).

Refractories; Their Physical Characteristics

The Research Laboratory of the Carborundum Co. presented two papers on refractories by M. L. HARTMANN and O. A. HOUGEN.

SPALLING LOSSES

The first paper was on "Spalling Losses" and covered comparative tests of the resistances of twelve different kinds of refractory bricks exposed to rapid cooling by an air blast after heating to 1,350 deg. C. This cooling was repeated up to ten treatments with nine bricks, while three were completely disintegrated at the seventh, fourth and third treatments. The results of all tests are summarized in the following table:

	Spalling at End of	Per Cent
1. Bonded carborundum (carbofrax C)	10th cooling	0.3
2. Bonded carborundum (carbofrax A)	10th cooling	6
3. Bonded carborundum (carbofrax B)	10th cooling	8
4. Grade A fireclay	10th cooling	9
5. Recrystallized carborundum (refrax)	10th cooling	12
6. Bauxite	10th cooling	43
7. Zirconia (natural)	10th cooling	53
8. Grade B fireclay	10th cooling	65
9. Grade C fireclay	10th cooling	90
10. Chrome	7th cooling	100
11. Silica	4th cooling	100
12. Magnesia	3d cooling	100

From five to ten bricks were used in each test. These were purchased in the open market and undoubtedly do not give absolute results for the various types of refractories. The general order of magnitude of spalling is probably correct, however.

COMPARATIVE COLD AND HOT ABRASION TESTS

The second paper was based on "Comparative Cold and Hot Abrasion Tests." These tests were made on different kinds of refractory materials, at ordinary temperatures and at 1,350 deg. C., by a carborundum cutting wheel under a constant pressure, and measuring the depth abraded in a given time. The results are summarized in the following table. While the figures are only roughly quantitative, they indicate the general relative resistances of these materials to abrasion.

TESTED HOT (1350 DEG. C. AT START)
(5-MINUTE PERIOD)

	Abrasion Inches
1. Bonded carborundum (carbofrax C)	0.01
2. Bonded carborundum (carbofrax A)	0.01
3. Bonded carborundum (carbofrax B)	0.03
4. Bauxite	0.04
5. Zirconia (natural)	0.06
6. Recrystallized carborundum (refrax)	0.07
7. Grade C fireclay	0.07
8. Grade B fireclay	0.09
9. Grade A fireclay	0.11
10. Chrome	0.27
11. Magnesia	12.50
12. Silica (lime bonded) spalled too badly for measurement.	

In discussing these two papers, F. A. J. FITZGERALD, of Niagara Falls, referred to the change in crystalline structure of certain bricks, in particular magnesite, which would naturally effect the spalling tendency. Furthermore, since the heat conductivity of the various bricks tested is widely different, the carborundum wheel test for abrasion does not seem to be satisfactory. Possibly a sand-blast test would be more reliable. Messrs. RICHARD, SAUNDERS and BANCROFT also participated in the disscusion.

The Smoker

The smoker was a distinct success. It was held in the laboratory of Arthur D. Little, Inc., beginning with a general inspection with incidental "exercises," which we shall describe later, and concluding in the assembly and lunch room. The tour began in the chemical museum on the main floor. This contains a large number of rare and interesting specimens as well as an illuminating exhibit of successive raw, intermediate and finished products of a great variety of industries. It is also so arranged as to show many things that could and should be done, for profit as well as for the improvement of human conditions, provided only the necessary research were undertaken and carried to a definite conclusion. It would be hard to find a better demonstration of the achievements of research on the one hand or of the amazing lack of initiative in industry to accomplish results that are at once available and greatly needed by this very means.

After a look through the administration offices the guests entered the basement, inspected semi-commercial scale apparatus and saw the experimental paper mill in operation, making A. D. L. filter paper; the entire plant being operated with distilled water. Following this the research laboratories, library and analytical laboratories were all visited, except the extraction room in which over-night work was in process. Then ensued a kind of competitive examination in olfactics, or of the nose efficiency of persons present.

AN EXAMINATION IN OLFACTICS

In one of the large rooms four tables were placed upon each of which were twelve similar bottles, corked and labeled with numbers. Each contained cotton wool moistened with 2 c.c. of an odoriferous body, and blanks were provided with spaces for the person's name and answers to be filled in. The key, which was known only to a committee of the staff, was: 1, almond extract; 2, kerosene; 3, oil of lime; 4, turpentine; 5, amyl acetate; 6, acetic acid; 7, carbon tetrachloride; 8, Worcestershire sauce; 9, carbolic acid; 10, ethyl alcohol; 11, oil of sassafras, and 12, vanilla extract. Nearly 80 per cent answered three-quarters of the numbers correctly, seven made only one mistake and only one, Dr. Alcan Hirsch of New York, gave the right answer to all twelve. He received the prize of a gold-headed silk umbrella. Some of the errors were interesting. Carbon bisulphide, iodoform and eucalyptol were mistaken for phenol, lactic acid for alcohol and acetic acid, menthol for turpentine and a majority thought sassafras was wintergreen. One wrote after No. 10 (alcohol), "familiar but cannot remember."

HUNTING WITH A CAMERA IN NEW BRUNSWICK WOODS

At about 9:30 the company repaired to the assembly room, where, after some lusty singing by the assembled 200 guests and some original songs by an employee of the laboratory written in the trenches in France, Lyman Underwood, a biologist of the faculty of the Institute of Technology, gave an illustrated talk on hunting with a camera in the New Brunswick woods. It was a very lively and interesting address and it made nearly everybody want to go and do likewise without delay. In introducing Mr. Underwood a member of Dr. Little's staff told a chemical story that should be profitable to those young men who want to study chemistry and nothing else. It seems a chemist of this sort was invited by an astronomer to look through his telescope with a field of a nebula in focus. "Huh!" exclaimed the chemist as a multitude of suns appeared, "the damned thing's colloidal!"

Refreshments were served at 11 o'clock and the occasion was acknowledged to have been one of the best smokers ever.

Symposium on Electrically Produced Alloys

The Friday morning session was a joint session with the American Institute of Electrical Engineers, and was held in the Copley Plaza Hotel. Dr. H. E. HOWE, of the National Research Council, introduced the subject with a brief discourse on "The Fundamental Problems in Alloys Research." A good deal of investigation is required, Dr. Howe said, in order to complete the published data on standard alloys. Likewise the testing of non-standard alloys should be undertaken and detailed physical and chemical properties tabulated and published. The corrosion problem is a very large one and has only been partly solved. Phase rule diagrams of ternary alloys are badly needed; very little has been published in this line. The effect of occluded gases on metals, specific heats of many metallurgical compounds, and best alloys for die casting are some of the other important problems that await solution. In conclusion Dr. Howe referred to the newly organized Alloys Research Association, which will devote its efforts initially to an informational service.

MANUFACTURE OF FERRO-ALLOYS IN THE ELECTRIC FURNACE

"The Manufacture of Ferro-Alloys in the Electric Furnace" was the title of a paper presented by C. B. GIBSON of the Westinghouse Co.

He stated that the demand for ferro-alloys is governed, to a large extent, by the requirements of the iron and steel industry. As specifications for ordinary, tool and alloy steels, and also castings, are becoming more rigid, the steel maker is depending on ferro-alloys to meet these requirements. The alloys in general use for deoxidizing are ferromanganese, ferrosilicon, etc. The alloys used for imparting to steel certain properties are ferromanganese, ferrochromium, ferrotungsten, ferromolybdenum, ferrovanadium, ferro-uranium, ferrotitanium, ferrozirconium, etc. After discussing briefly the specific uses of these alloys, the author gave some data in regard to power and raw material consumption in the manufacture of some ferro-alloys.

In laying out new furnace installations, or in planning to improve the operating conditions of existing ones, a careful study is essential of the problems relating to the bus and cable layout. Relatively the problems involved in 25-cycle installations, for the same size furnace, are not as serious as for 60-cycle, for the reason that maximum energy that can be fed into a constant voltage circuit at different frequencies is inversely proportional to the frequency. In other words, where a 10,000-hp., 60-cycle furnace is about the limiting size for a well-designed furnace and bus layout, 22,000 hp. is the corresponding size for a 25-cycle furnace.

In the discussion of Mr. Gibson's paper it was pointed out that the United States had two serious competitors in the ferro-alloy field—Canada and Norway. Dr. BANCROFT asked whether it was possible to predict at this time whether 25- or 60-cycle current is going to win out. Mr. Gibson replied that at present it was difficult to say; similarly, the limiting size of furnace cannot be predicted today; 3,000-kw. furnaces appear to be amply large. Dr. RICHARDS referred to the blast furnace as a competitor of the electric furnace and believed it to be possible to make 50 per cent ferrosilicon in the blast furnace if oxygen-enriched air were used. Dr. FINK in reply stated that highly concentrated electrical energy was usually cheaper than highly concentrated chemical energy and 50 per cent ferrosilicon made in the blast furnace would be comparatively costly.

DEVELOPMENT OF FERROVANADIUM METALLURGY

Another paper of the symposium was presented by B. O. SAKLATWALLA, general superintendent of the Vanadium Corporation of America, on "The Development of Ferrovanadium Metallurgy." The speaker referred to the modern introduction of vanadium into large-scale metallurgical practice, in armor plate and special steels. He described the methods of reducing vanadium compounds to metal by silicon in the electric furnace; by the alumino-thermic process, and finally by carbon.

In the discussion of Mr. Saklatwalla's paper GEORGE M. BERRY, of Syracuse, brought up the question of the future supply of vanadium and its steadily increasing cost. According to Mr. Saklatwalla there is only one deposit of importance, that of Peru.[1]

The supply has not been able to keep pace with the demand. Replying to Mr. GILLETT'S question, it was brought out that the percentage of carbon in the new carbon-reduced ferrovanadium is no higher than that of the former aluminum-reduced ferrovanadium (carbon derived from the lining). As to the somewhat higher silicon content found by Mr. Berry in the new product, Mr. NORRIS of the Vanadium Corporation stated that there is no objection to this silicon content in electric-steel manufacture, since the silicon can be slagged off readily. In the crucible process there might be difficulty in keeping the silicon content of the tool steel down. Others participating in the discussion were Messrs. BANCROFT, FINK and RICHARDS.

MANUFACTURE OF STELLITE

Mr. ELWOOD HAYNES of Kokomo, Ind., contributed an account of the present day manufacture of stellite, the well known tool steel. He referred also to many of the very remarkable physical and chemical properties. Dr. S. A. TUCKER of the Chemical Foundation inquired regarding the high price of the alloy and ventured to state that the present limited use of the alloy was due to its cost alone. Dr. FINK referred to Mr. Haynes' difficulties in the past in attaining uniform results when the alloy was made in an oil- or gas-fired furnace. Today, however, stellite is made in the electric furnace and the product is absolutely uniform in quality, strength and hardness. Dr. RICHARDS added that when making armor plate by the open-hearth process, 50 per cent of the chromium is lost.

FERROSILICON AND OTHER SPECIAL ALLOYS

"Ferrosilicon" was the subject of a paper by F. A. RAVEN, of the Canadian Ferro-Alloys, Ltd. Ferrosilicon is one of the most important of all ferro-alloys. The paper included a very interesting account of the various grades of ferrosilicon; description of the older and modern processes of manufacture; methods of grading; various applications of the alloys; and discussion of the electric furnaces best adapted to alloy manufacture.

RALPH M. MAJOR, of the Driver Harris Co., Harrison, N. J., gave an illustrated talk of the manufacture of nichrome, climax, invar and other special alloys made by his company.

In the discussion Dr. BANCROFT described the nichrome tubes that were used by the Government dur-

[1] See *Eng. and Mining J.*, April 3, 1920, p. 814.

ing the war for heating and activating nut charcoal. Messrs. TUCKER and WEISER discussed the forgeability, hardness and resistance to wear at elevated temperatures of the alloy nichrome. Mr. MAJOR said that there was not yet very much data available along these lines, but that tests are under way. Nichrome will stand about as much wear, when hot, as steel. It can be made very hard by working but not by heat treatment.

The Anaconda Copper Mining Co.'s experience in the electrical production of ferromanganese was related by E. S. BARDWELL, of the Great Falls staff.[2]

HIGH-SPEED STEEL

Of the complex alloys made in the electric furnace, high-speed steel is among the most important. A detailed account of its manufacture was presented by ROY C. MCKENNA, president of the Vanadium Alloys Steel Co. By the electric-furnace process the vanadium content of high-speed steel can easily be maintained within much narrower limits than by the crucible process. The average power consumption of a 3-ton heat of high-speed steel melted in a 3-ton Heroult furnace is 1,000 kw.-hr.; 40 lb. of carbon electrodes per heat; 80 heats per lining.

In discussing Mr. McKenna's paper, Mr. NORRIS reported that ferrovanadium with 20 per cent silicon had been successfully used in the electric furnaces. F. W. BROOKE, of Philadelphia, emphasized the importance of deoxidizing the slag before adding the ferrovanadium. Formerly too little attention was paid to this point.

"The Electrolytic Production of Ferrocerium" was described by Dr. ALCAN HIRSCH, of New York. The raw materials for cerium are the residues of the gas mantle industry. These are purified and the cerium salt is introduced into a fused bath. During electrolysis the current and voltage is carefully controlled and regulated. The metal is cast into small 8-in. molds. This is next alloyed with iron (30 per cent) or magnesium or copper. The ferrocerium is used in the manufacture of pyrophoric lighters. Dr. Moldenke has tried it out as a deoxidizer for steel, producing a very soft product, practically free from gas and with little internal shrinkage. The magnesium-cerium alloy is used for miners' lamps, where the flame effect is more desirable. Tests made on copper bars showed that the addition of a small percentage of cuprocerium to the molten copper increased the ultimate strength of the rolled or drawn metal from 25,000 lb. per sq.in. (without Ce) up to 26,740 (with Ce addition); elongation 28.4 and 33.5; and reduction in area, 23.6 and 37.8 respectively.

The paper was discussed by Messers. GILLETT, BULLOCK, BENJAMIN, FINK and BRAID.

"The Magnetic and Electrical Properties of Iron-Nickel Alloys" was the title of an A.I.E.E. paper submitted by Dr. T. D. YENSEN, of the Westinghouse Co. He reported upon a series of careful experiments on the permeability and hysteresis loss of Fe-Ni alloys, a paper which will be abstracted in a subsequent issue of CHEMICAL AND METALLURGICAL ENGINEERING.

[2]This paper was published in full in this journal April 14, 1920, p. 681.

W. S. LANDIS
New President of the American Electro-Chemical Society

ELECTRICAL PROPERTIES OF TITANIUM ALLOYS

Prof. M. A. HUNTER and J. W. BACON, of the Rensselaer Polytechnic Institute, investigated "The Electrical Properties of Titanium Alloys." They found that the addition of titanium to iron improves the magnetic quality of the iron. Alloys of titanium with nickel, copper, nickel-iron and nickel-copper were made. The resistances of these materials are only moderately high for additions of titanium up to 5 per cent. Beyond this point the alloys are exceedingly hard to draw.

Dr. YENSEN, in discussing Hunter and Bacon's paper, referred to experiments he had carried out on ferro-titanium alloys. His results seemed to show that there was no advantage in using titanium. In general better results were obtained with silicon and aluminum than with either titanium or boron.

Exhibit of Electrically Produced Alloys

In conjunction with the symposium a very attractive and instructive display of the various alloys produced in the electric furnace and electrolytic cell had been arranged by R. P. HOMMEL. Among the novelties were sheets of electrolytically deposited brass (¼ in. thick) and brass-plated steel submitted by GEORGE HOGABOOM; a large sample of silicon-zirconium from the Electrometallurgical Co., Niagara Falls; and rods of ductile aluminum silicide (tensile strength 30,000; elongation 5 to 6 per cent) submitted by the Alpax Laboratories of Cleveland.

Fixation of Atmospheric Nitrogen

C. FRANCIS HARDING and K. B. MCEACHRON, of Purdue University, gave a detailed account of their experimental studies of the fixation of atmospheric nitrogen by the silent electric discharge (Paper published in the *Journal*, A.I.E.E., April).

Power for Electrochemical Purposes

The Friday evening session was likewise a joint session with the American Institute of Electrical Engineers. That most vital of all topics—power—was discussed by many of the chemists and engineers assembled. President C. TOWNLEY of the Institute presided. JOHN L. HARPER opened the discussion with a paper on "Power for Electrochemical Purposes." He confined most of his attention to developments, both past and future, in the eastern section of the country. Here was a potential power of 1,900,000 kw. At Niagara today there were 500,000 kw. developed.

ELECTRIC-FURNACE POWER FROM THE STANDPOINT OF THE CENTRAL STATION

E. A. WILCOX, in his dissertation on "The Electric-Furnace Power From the Standpoint of the Central

Station," reviewed the entire situation in detail. He believed that a small electric furnace operating rapidly is preferable to a slow large unit. Furthermore, frequent heats mean less floor space. Electric-furnace power has many advantages: large blocks, no close regulation of service voltage as is required in lighting service, and more constant and steady demand and supply than interurban car or street car service. As a rule three-phase power is to be recommended.

Power Problems From the Standpoint of the Furnace Operator

Wallace G. Berlin, of High Bridge, N. J., discussed "The Power Problems From the Standpoint of the Furnace Operator." He talked chiefly of the power requirements when melting cold charges in the steel furnace.

In the open discussion, F. Hodson, of Philadelphia, recommended the installation of graphic meters very highly and considered it poor practice to overload the furnace. Mr. Benjamin urged a wider use of off-peak power for various electrolytic processes. Dr. Hering strongly favored the use of small furnaces at high speed on account of the much higher economy. Mr. Gail referred to the frequent unsatisfactory tariff contract. H. A. Winne said that a series of electric furnaces could be operated at a time very cheaply if a fixed schedule was adhered to. Mr. Hess favored the cold charge for the highest quality electric steel.

Automatic Control of Arc-Furnace Electrodes

"Automatic Control of Arc-Furnace Electrodes" was the title of J. A. Seede's paper. He described and illustrated the regulator he invented at the Schenectady works and referred briefly to numerous installations which had been operating satisfactorily for the past ten or twelve years. In contradistinction to the Thury regulator, which is of the intermittent control type, the Seede regulator is of the continuous control type. Provisions are made in case power is shut off completely. The close regulation obtainable was strikingly demonstrated by a series of charts from a curve drawing instrument connected into the circuit of an electric alloy steel furnace.

Other Papers

Harvey A. Winne of Schenectady presented a paper on "Reactors for Electric-Furnace Circuits."

C. T. Maynard described the plant of the Rumford Falls Power Co. in Maine, and pointed out the many advantages of this "Location for a New England Electrochemical Plant." About 35,000,000 kw.-hr. per year are available for immediate use as continuous primary power and about 40,000,000 kw.-hr. per year more of secondary power.

F. F. Fowler presented a discourse on "The Water Powers of the Pacific Coast." He discussed in detail the coastal rainfall, cause of present power shortage, Columbia River power development (estimated price, $15 per hp.-yr. on the basis of immediate sale of all the power), availability of raw materials, etc. Puget Sound is today the most favorable locality. In California the net minimum cost is $32 with a power factor 95 per cent and a load factor of 100 per cent.

The final paper of the symposium was that of Dr. J. W. Beckman, of San Francisco, on "Power Developments in Scandinavia." Dr. Beckman showed how active has been the development of water power in Scandinavia, fostered by wiser legislation on the subject than in the United States.

Visits to Industrial Plants

On Friday afternoon the members were the guests of the General Electric Co. and an interesting and instructive tour was made through the River Works and the old Thomson Houston plant on Federal St., Lynn. Of special interest was the inspection of the Heroult electric furnace in the steel foundry which was in "full blast."

On Saturday afternoon the plant of the Huff Electrostatic Separator Co. of Arlington was visited. William E. McKee of the company had arranged a very striking display of some of the results obtained with the separator and demonstrated the actual working of the apparatus. Of special interest was the concentration of graphite from native Alabama and Pennsylvania ores resulting in a high-grade product "Electrophite," used in the manufacture of plumbago crucibles. Other noteworthy separations were those made on Florida sands resulting in a 98.5 per cent TiO_2 product on the one hand and a 97.8 per cent ZrO_2 product on the other; and separation of zinc from gold, silver, lead, copper and iron in complex ores.

Saturday Morning at Harvard University

In his address of welcome, Prof. T. W. Richards referred to Benjamin Thompson's (Count Rumford) activities and pointed out that his early lecture notes were still preserved at Harvard. The first paper on the program was that of Joseph W. Richards on "The Söderberg Self-Baking Continuous Electrode."

Briefly, this arrangement calls for a mechanism situated on a working floor directly above the furnace, which forms and feeds the vertical electrodes just as fast as they are consumed on the lower end by the furnace.

This paper aroused considerable interest and was admitted to be one of the most important of the meeting. A member of the Southern Ferromanganese Corporation pointed out that three of its electric furnaces are being equipped with Söderberg electrodes and that Mr. Swann is fully confident of success. The electrodes are 32 in. in diameter and will be in operation next month. In reply to questions put by Messrs. Tucker and Saunders, Dr. Richards stated that the electrical resistance of the hard-baked Söderberg electrode was the same as that of the ordinary electrodes of today. As regards the smoke due to the binder, pitch and tar, this does not vitiate the atmosphere of the foundry, since it is forced downward into the furnace and is there consumed. Furthermore, the baking of the Söderberg e'ectrodes proceeds so very slowly, about one meter per week, that there is very little smoke produced per unit time. As regards possible iron contamination from the metal casing of the electrode, it was found by actual test that in calcium carbide furnaces the product contained but 0.2 per cent Fe. If the Söderberg electrode were to be used for aluminum furnaces, an aluminum casing could easily be substituted for the iron casing.

Synthetic Electric-Furnace Cast Iron

Charles Albert Keller, director of Keller & Leleux of Paris, contributed an interesting illustrated account of the production of "Synthetic Electric-Furnace Cast Iron," substantially the same as was published in Chem-

ICAL & METALLURGICAL ENGINEERING, vol. 22, p. 83. In the disscussion of Mr. Keller's paper, F. W. BROOKE, of the Electric Furnace Construction Co. of Philadelphia, emphasized the difficulties in obtaining high carbon cast iron from melting steel turnings in the electric furnace.

STEP INDUCTION REGULATOR FOR ELECTRIC FURNACES

PHILIP B. SHORT, of the Westinghouse Co., presented a brief paper on a new "Step Induction Regulator for Electric Furnaces." The equipment consists of a combination induction type regulator, a selector switch, a transformer switch, a series transformer and a suitable panel for meters and switches. Photographs were shown of equipment recently designed for twenty electric zinc furnaces in Norway.

L. E. SAUNDERS congratulated the company upon the design and production of this new regulator and felt convinced that with the introduction of this regulator a great saving in cost of operation could be looked forward to.

EVOLUTION OF THE ELECTRIC BRASS FURNACE

The next paper, by H. M. ST. JOHN, of the Detroit Electric Furnace Co., on "The Evolution of the Electric Brass Furnace," gave rise to a very spirited discussion.

Mr. St. John divided electric furnaces applicable to brass melting into three groups and discussed the evolution of commercial types in each group.

The indirect resistance type, in which heat is generated in a resistor and transferred by radiation or conduction to the metal to be heated, resulted from the tendency of the first designers to copy combustion furnaces. Various resistors have been employed in the electric crucible furnace, but none have met with marked success. A recent addition to this group is the high-tension, high-frequency induction furnace in which the walls of the crucible itself are electrically conducting and serve to heat the contents during the period while the metal is still solid. By placing an incandescent resistor in the top of the furnace, crucibles may be dispensed with, and the design simulates that of an open-hearth furnace. One successful furnace employs an overhead granular resistor contained in a nearly circular refractory trough.

In the induction- or direct-resistance type the heat is generated by the direct resistance of the metal itself. These furnaces utilize the pinch-effect phenomenon, the latest modification being the vertical-ring induction furnace, which is recommended only for 24-hr. operation melting yellow brass.

With arc furnaces, the heat is transferred to the metal directly or indirectly by conduction or radiation. Volatilization and oxidation losses are high in the direct-arc type, so this has given way to indirect-arc furnaces which are either rocking or rotating for the purpose of maintaining uniformity of temperature throughout the molten bath.

A consideration of what the brass foundryman could expect from the use of electric furnaces brought out the following data in regard to energy consumption:

The consumption of electric energy under average conditions of 8- to 10-hr. operation is as low as 240-kw.-hr. per short ton for yellow brass, and 275 kw.-hr. per ton for red brass, in the induction or arc furnaces. In 24-hr. operation figures as low as 200 kw.-hr. per ton or less have been obtained. Less efficient furnace types use from 400 to 500 kw.-hr. per ton, depending upon conditions.

Messrs. FINK, WINDER, CROSBY, TUCKER, GILLETT, CONE, WEISER, BAILY, HERING and RICHARDS participated in the discussion. The main point at issue was the kilowatt-hour consumption per ton of yellow brass.

C. A. WINDER, of the General Electric Co., felt that Mr. St. John had not sufficiently emphasized the advantages of other than arc type brass furnaces. The low zinc losses of the resistance-type furnaces due to lower temperatures of operation, the cleansing action of the pinch and induction-type furnaces, reducing the oxide contamination to a minimum, besides effecting a uniform temperature in the alloy itself, were points well worth while considering. At present there seems to be a field for every one of the five types of brass furnaces. L. E. CROSBY, of Detroit, submitted figures of performance of the "rocking" furnace. At ten different installations, melting 60-40 and 70-30 brasses, the consumption of electrical energy amounted to 240 kw.-hr. and less for an 8- to 10-hr. day. At one of the brass foundries a six months' record (8-hr. day) showed an average of 215 kw.-hr. per ton of brass. Bronzes containing 92 per cent copper require more power. As regards uniformity of temperature of the molten brass in the rocking furnace, direct measurements indicated a variation of not over 3 deg. C. The furnace rocks every 40 seconds and therefore big differences in temperatures do not obtain. Furthermore, contamination by oxides is very slight since the atmosphere in the furnace is a reducing one (CO gas). The actual tonnage turned out by the rocking furnace today is about twice that of any other type of brass furnace. H. W. GILLETT, of the Bureau of Mines, Ithaca, N. Y., cited the performance of an induction furnace at the American Brass Co.'s plant: A ton of yellow brass was melted in 174 kw.-hr.; 240 kw.-hr. was certainly not impossible, as Mr. Winder contended; every brass furnace ought to do as well as that. Dr. CARL HERING, of Philadelphia, put in a plea for the induction type or pinch effect furnace. An important point besides power consumption is low loss of zinc; in induction furnaces this loss is very low. Then there is the self-regulating feature of the induction furnace, whereby the temperature of the metal is kept within narrow limits. As soon as the temperature rises too high a small zinc bubble is formed and the circuit is broken. There are about eighty-four induction type brass furnaces in operation today. Mr. CONE of *Iron Age* added that today there are about 300 electric brass furnaces in operation, including all types.

F. S. WEISER, of the Scovill Mfg. Co., regretted that there were not yet available reliable relative data on the performance of the different types of brass furnaces, giving the life of linings, cost of operation, metal losses, etc., in each case. T. F. BAILY, of the Electric Furnace Co., Alliance, Ohio, said that in the operation of his resistance furnace 285 kw.-hr. is required per ton of yellow brass.

Dr. RICHARDS, in commenting on metal losses, pointed out that a saving of 1 per cent of zinc during melting was equivalent to about 64 kw.-hr. (1c. kw.-hr.) and that the theoretical power consumption for melting brass was about 130 to 150 kw.-hr. Zinc does not boil out of brass until the melting point of copper is reached.

In discussing "The Melting of Lead Alloys" in the electric brass furnace, Mr. WINDER stated that the induction furnace could not handle alloys higher than 2 per cent lead on account of rapid deterioration of the furnace lining. Mr. GILLETT quoted results obtained by Clamer in the induction furnace, showing that good results were obtained with 6 per cent lead alloys. Mr. CROSBY referred to the experience of the Michigan Smelting & Refining Co. It is melting a 26 per cent lead alloy in a 2,000-lb. rocking arc type furnace with a maximum deviation of lead of 0.6 per cent Pb.

THE ELECTRIC FURNACE IN IRON AND STEEL METALLURGY

The next paper was presented by LEWIS B. LINDEMUTH, of New York, on "The Position of the Electric Furnace in Iron and Steel Metallurgy." He gave a detailed comparison between the physical and chemical characteristics and phenomena of the four steel-making processes, bessemer, open-hearth, crucible and electric-furnace. The advantages of the electric furnace he dwelt upon in detail and concluded that the electric furnace, when properly installed and operated, is metallurgically the best steel-making apparatus we have, and economically the cheapest.

In discussing the paper Dr. RICHARDS, of Lehigh University, ventured to predict that the day is not far distant when all steel will be finished in the electric furnace. As a piece of apparatus for refining or finishing steel, the electric furnace has no competitor. The duplexing and triplexing systems are gaining favor.

ELECTRIC ARC MELTING FURNACE AND THE CENTRAL STATION ELECTRIC COMPANY

"The Electric Arc Melting Furnace and the Central Station Electric Company" was the title of the next paper, presented by AUGUSTUS C. SMITH, of the Buffalo General Electric Co. Tests on arc furnaces with an Esterline graphic meter were made and very accurate records of the characteristic use of electrical energy were secured. Photographic copies of these graphic records were shown. Many of these reveal great surges which cause serious disturbances in the central station's lines. Mr. Smith pointed out, however, that with a certain amount of care in the operation of the electric furnace the surges can be practically eliminated.

In discussing Mr. Smith's paper Mr. COE felt certain that abnormally large surges could easily be eliminated by introducing automatic reactors into the circuit. Mr. NOYES outlined the very efficient system of the Detroit Edison Co. in supplying power to various electric foundries. Small substations are located at or near the electric foundry, and these substations are fed by 23,000-volt feeders, entirely separate from the lighting circuits.

ELECTRIC FURNACE AS APPLIED TO METALLURGY

A very valuable compilation of the literature of "The Electric Furnace as Applied to Metallurgy" was submitted by CLARENCE J. WEST, of the Arthur D. Little Laboratories. This compilation covers the years 1900 to 1919 and will be greatly appreciated by all students of electrometallurgy.

RESOLUTION OFFERED BY DR. RICHARDS OF LEHIGH AND VISIT TO THE T. W. RICHARDS LABORATORIES

In bringing the session to a close, Dr. RICHARDS of Lehigh offered a resolution embodying the hearty support of the American Electrochemical Society of the undertaking of the National Research Council in collecting and publishing its tables of critical physical and chemical constants, the Society recognizing full well the valuable aid to research and industry of tables of this kind. Dr. Richards of Harvard suggested that detailed references to all data be given; also references to values not included in the tables. Dr. Bancroft in reply assured the members that no effort would be spared in making the tables as complete as possible. The selection of the most probable value will in each case be left to an expert or group of experts. The National Research Council hoped to accomplish in the case of these tables what has been done in the past for atomic weight determinations.

Before adjourning for luncheon at Harvard Union Dr. T. W. Richards invited the members to visit his new laboratories, where measurements of highest precision are carried out. These laboratories are absolutely dust-proof and provisions are made throughout for the elimination of influences and effects that might give rise to inaccuracies in the use or operation of mechanical and electrical apparatus and instruments. There were buttons of the purest silver in the world, a large crystal of gallium and beautiful specimens of indium on display.

February Exports Show Decline

A decided drop in exports was the outstanding feature of the February foreign-trade statement issued by the Bureau of Foreign and Domestic Commerce, Department of Commerce.

February exports amounted to $646,000,000, the smallest since October of last year, against $722,000,000 in the preceding month of January and $585,000,000 in February of last year. Exports during the eight months ended with February were $5,231,000,000, against $4,383,000,000 in the eight months of last year.

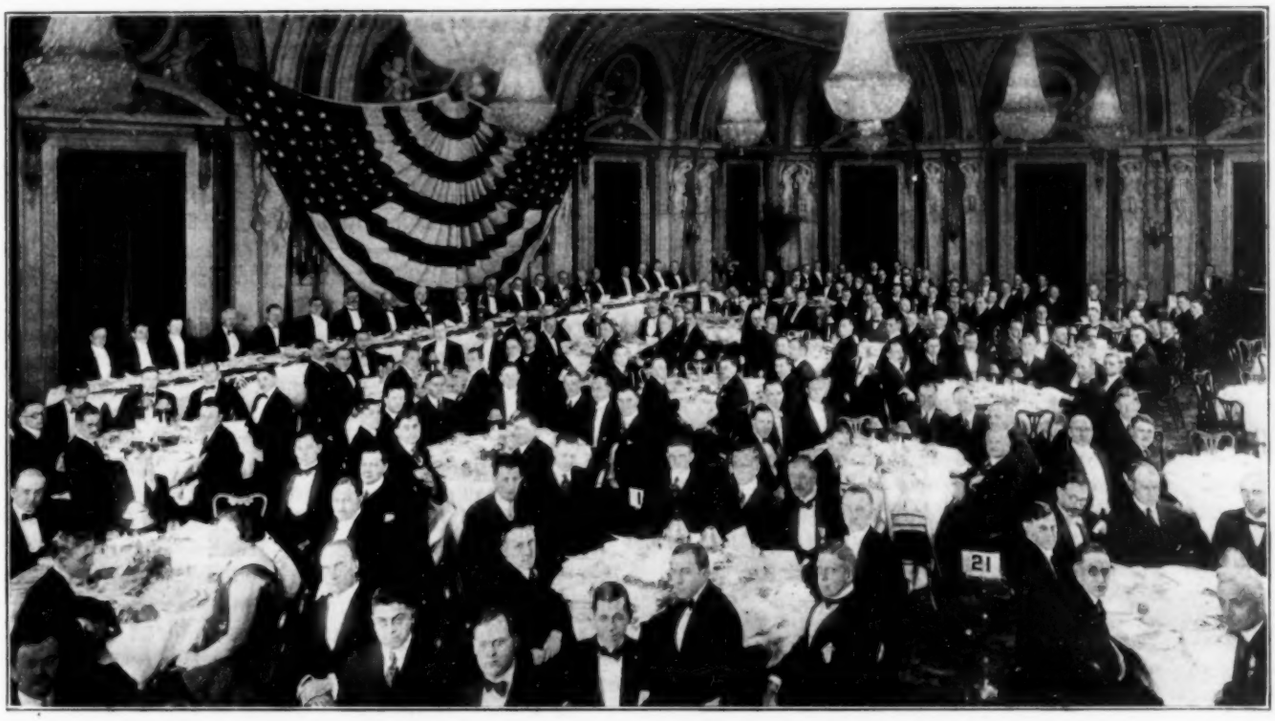
February imports amounted to $467,000,000, against $474,000,000 in January of this year and $235,000,000 in February a year ago. Imports during the eight months' period ended with February amounted to $3,235,000,000, against $1,933,000,000 a year ago. The imports during these eight months, representing two-thirds of the current fiscal year, exceeded by $140,000,000 the imports during the entire fiscal year ended with June, 1919.

Bronze Powder and Metal Leaf Industry in Japan

The statement that the Japanese bronze powder and metal leaf industry, which was making rapid progress before the war, grew phenomenally as a natural result of the cessation of their competitors, appears in an issue of *Commercial Osaka*. Several new companies were formed, including one having a monthly capacity of 100,000 lb. of bronze powder in addition to producing copper and aluminum powders and gold leaf.

Co-operation (!) During Reconstruction

The Société des Mines de Potasse de Sainte-Thérèse sent to the Portland Cement Werke Wetterau, of Langfurt a/M., a letter requesting an offer of cement and received the following reply: "It is agreeable to us to note by your request that France is in a state of economic dependence and we decline to come to her aid."—*The Review*, March 15, 1920.



T.A.P.P.I. BANQUET AT HOTEL ASTOR, APRIL 14, 1920

Fifth Annual Meeting of T.A.P.P.I.

Address of Welcome Given by George Sisson, President of the American Paper and Pulp Association—Presidential Address by Raymond S. Hatch—Election of Officers—Social Features, Including Banquet at Hotel Astor

THE fifth annual meeting of the Technical Association of the Pulp and Paper Industry was held April 13 to 15 in the Waldorf-Astoria, New York City. It was well attended and the program was well arranged and interesting.

Tuesday was devoted to meetings of the various standing committees, and registration of members and guests.

Society to Publish Journal

The first general session began on the second day. Raymond S. Hatch, president of the association, spoke of the growth of the society, which now numbers 535, and of the work it has accomplished. He also suggested the need of a technical journal controlled and operated by the association. This paper is to be devoted to the transactions of the association and to contain such technical information as pertains to the paper industry. The matter was favorably acted upon and referred to members of the finance and executive committees to devise ways and means of carrying out the project.

Address of Welcome

George Sisson, president of the American Pulp and Paper Association, delivered an address of welcome in which he emphasized the excellent work of the National Association of the Pulp and Paper Industry, and expressed the desire, on behalf of the American Pulp and Paper Association, to co-operate in every way possible to further the good work.

The rest of the morning session was taken up with reports of the committees and the election of officers.

Election of Officers

Officers elected for the ensuing year are: President, Raymond S. Hatch, the Hamersley Manufacturing Co., Garfield, N. J.; vice-president, Robert B. Wolf, Aeolian Building, New York, N. Y.; secretary-treasurer, Thomas J. Keenan, 471 Fourth Ave., New York, N. Y.; executive committee, Raymond S. Hatch, chairman; Robert B. Wolf; Henry E. Fletcher, Fletcher Paper Co., Alpena, Mich.; Frederick C. Clark, American Writing Paper Co., Holyoke, Mass.; Henry P. Carruth, Mead Pulp & Paper Co., Chillicothe, Ohio; Royal S. Kellogg, News Print Service Bureau, 18 E. 41st St., New York City; George E. Williamson, Strathmore Paper Co., Mitteneague, Mass.

Wednesday afternoon and all day Thursday were devoted to the presentation and discussion of the various papers, and to symposiums, the nature of which will be reviewed in a later issue of CHEMICAL & METALLURGICAL ENGINEERING.

Wednesday evening at 7 o'clock the members gathered for a reception in the Hotel Astor, followed by a banquet in the East Ball Room.

Judge Charles F. Moore, as toastmaster, spoke in the highest terms of the work done by the association for the paper industry, and of the appreciation by the men in the paper field of the chemical profession for its labors. He brought out the fact that the future success of the paper industry depended upon technical research, and that the very existence of the operators in the future depended upon the work of the technical men, and therefore the operators should support their work both financially and morally.

Herbert Hoover was to have been a guest of honor at the banquet, but owing to pressure of the many demands upon his time, he was unable to attend. He did, however, send his regrets and appreciation to T.A.P.P.I. and wished the association success in its work.

Dr. William H. Walker, of the Massachusetts Institute of Technology, gave a few reminiscences of his experiences in the early days of paper making and then explained a plan which M. I. T. is using to disseminate among the industry the vast store of information now collected and available in the institution.

Need of Vocational Education

Dr. Charles Baskerville, of the College of the City of New York, commented on vocational education and the dearth of trained men in this country of managerial capacity. He said that the three great factors of our prosperity are raw materials, money and men, and that although the country had the two former it lacked the trained men. Vocational education is a scheme to meet, in a measure, this situation. Dr. Baskerville also compared man to an instrument capable of development and not a mere receptacle of knowledge.

Howard S. Neiman, of New York City, told how T.A.P.P.I. protected the paper industry, and encouraged young men to go into the business.

Course Prepared by Vocational Education Committee

George Carruthers, president of Interlake Tissue Mills, Ltd., Toronto, Canada, said that 90 per cent of the managers of the Canadian paper mills were Americans. He laid special stress upon a new series of textbooks and correspondence courses now being prepared by the Vocational Education Committee of the Pulp and Paper Industry. This course aims to educate the men in the paper industry to a clearer insight of their own work and its relation to the industry as a whole, and also to fit them for more responsible positions.

Mr. Chipman, president of the Canadian Pulp & Paper Co., gave an outline of the meeting to be held in Canada and cordially extended an invitation for all present to come.

The Human Factor in Industry

John Stadler, of Belgo-Canadian Pulp & Paper Co., Ltd., Shawinigan Falls, Canada, the last speaker on the program, seconded Mr. Chipman's invitation, and then spoke of the human factor in industry. He did not consider this element as a commodity with a nominal market price, but something infinitely more vital with latent and potential capacities, upon which the development of the industry depended. Too much emphasis has been laid on the material side of the question and not enough on the human. He would bring the development of the man power of the organization to a higher plane through well-directed vocational education and co-operation with the management.

Crude Phosphate Situation in France

Agricultural science and intensive farming being highly developed in France, that country is a large user of superphosphate. In 1913 France consumed, in the manufacture of superphosphate, 1,100,000 tons of crude phosphate, which was obtained from the following sources: Algiers and Tunis, 795,000 tons; United States, 145,000 tons; and France, 160,000 tons.

During the years of the war France imported the following quantities of crude phosphate: In 1914, 787,000 tons; 1915, 346,000 tons; 1916, 321,000 tons; 1917, 258,000 tons; and 1918, 247,000 tons. The decrease in the use of crude phosphate was due to the lack of transportation facilities and to the fact that sulphuric acid was required as an essential in war industries. Prior to the war the annual production of superphosphate in France amounted to 2,000,000 tons, an amount sufficient for French consumption and for the export of 50,000 tons. During the war capacity for production of sulphuric acid was doubled. A greater part of this increase in productive capacity will ultimately be employed in the manufacture of the superphosphate, but this is not practical at the present time, as vessels and rail accommodation are lacking for the transportation of phosphate and also of pyrites and coal.

The French Government allocated the African phosphate production for the year 1919 as follows: France, 700,000 tons; England, 247,600; Italy, 355,000; Portugal, 14,700; Belgium, 3,600; Switzerland, 5,500; Spain, 734,600; making a total of 1,400,000 tons. But of the total amount allocated for French use, namely, 700,000 tons, only 200,000 tons were imported in the first semester, owing to the impossibility of securing vessels for transportation.

The needs of various European countries for crude phosphate in the year 1919 were estimated as follows, according to the *Fortnightly Review*, published by the American Chamber of Commerce, at Paris: France, 1,100,000 tons; Italy, 600,000 tons; England, 400,000 tons; Spain, 200,000 tons; Belgium, 100,000 tons; Netherlands, 100,000 tons; Portugal, 50,000 tons; Scandinavian countries, 40,000 tons; Switzerland, 10,000 tons; total, 2,600,000 tons.

Exports and Imports of Chemicals

Exports of chemicals during February were valued at $13,209,935, according to figures compiled by the Bureau of Foreign and Domestic Commerce. Some of the items making up that total, as well as revised figures for February of 1919, are as follows:

EXPORTS OF CHEMICALS

	Feb. 1919	Feb. 1920
Acids:	Lb.	Lb.
Carbolic	27,372	97,534
Nitric	26,136	34,003
Picric	71	718
Sulphuric	767,792	2,025,311
Benzol	228,852	107,460
Calcium carbide	1,098,033	1,142,185
Copper sulphate	893,238	97,635
Wood alcohol	11,912	177,388
	Value	Value
Total sodas	$ 1,943,796	$ 1,706,556
Total chemicals	12,234,579	13,209,935
Total dyes and dyestuffs	2,018,642	2,461,797
Medicinal and pharmaceutical preparations	1,530,786	1,594,135

Some of the import figures, as compiled by the Bureau of Foreign and Domestic Commerce, are as follows:

IMPORTS OF CHEMICALS

Chemicals:	Value	Value
Free	$5,516,840	$11,878,274
Duty	3,896,713	4,725,832
Coal-tar products	400,345	350,174
Gums	2,012,186	4,363,893

Genesis of Ferrite

Contrary to Commonly Accepted Ideas, the Ferrite in Hypo-Eutectoid Steels Is Not Extruded as a Shell to the Outside of Austenitic Kernels, but Exists as an Aggregation of Crystals Essentially Discontinuous and Originating at the Low-Carbon Nuclei of Solid Solution Grains

By FEDERICO GIOLITTI

THAT α and β iron have an essentially different crystalline habit, and that the excess constituent in hypo-eutectoid steel does not collect at the periphery of austenite crystals in slowly cooled clean steel, can be demonstrated by direct observation of the various phases of formation of the ferrite itself, evidently the most direct and surest method of attacking the problem. Such demonstration appears necessary and is worthy of emphasis on account of the great practical importance of granular structure in steel and because so many erroneous ideas on its genesis appear in the literature. Especially, in the light of his own experiments, must the present author take issue with the eminent American Dr. Henry M. Howe in the latter's conclusions that ferrite is expelled to the outside of austenite grains on slow cooling, an idea developed at length in a paper entitled "Life History of Network and Ferrite Grains in Carbon Steel," published in the *Proceedings* of the American Society for Testing Materials, 1911, vol. 11, p. 271, and in his recent book on "The Metallography of Steel and Cast Iron."

I have presented reasons for believing that β iron crystallizes in rounded grains as compared to very flat plates, the normal habit of α iron, in an article entitled "Crystallography of Alpha and Beta Iron" appearing in CHEMICAL & METALLURGICAL ENGINEERING, vol. 22, p. 585 (March 31, 1920). In the present paper, the microscopic evidence further supports the hypothesis there set forth, but the primary purpose now is to establish my contention that ferrite meshes are essentially discontinuous chains of crystals and do not outline the original austenitic grain boundaries.

First Appearance of Ferrite

A few years ago the present author, with the aid of N. Boyer, conducted a series of experiments on a very well made, clean steel of the following composition:

	Per Cent		Per Cent
C	0.62	S	0.02
Mn	0.58	P	0.03
Si	0.07		

Some results of these experiments were presented at the time before the Academy of Sciences of Turin[1]. This steel had been forged into a bar 30 mm. square. Six blocks, 25 mm. long, were then cut off and suspended in a salt bath at 900 deg. C. for 1 hr. At the end of that time the fire was drawn and the bath slowly cooled, under constant stirring. When the temperature had fallen to 750 deg. C., one of the pieces was quickly withdrawn and quenched in water at room temperature, the second cube quenched when the temperature had fallen to 740 deg. C., and so on by 10 deg. steps, the sixth being withdrawn at 700 deg. C. All samples were then reheated in a lead bath at approximately 575 deg. C. to transform the martensite into sorbite.

[1]Vol. 48, p. 1.

When examined, the pieces quenched from 750 and 740 deg. C. were found to show sorbite and troostite, with no ferrite accumulations of microscopic size, which, indeed, could have been predicted. Fig. 1 gives the appearance at 160 diameters of the piece cooled to 730 deg. C. and then quenched[2]. Here are seen the first crystallites of ferrite which have separated out of austenite during the brief range from 740 deg. (the approximate temperature of germination of ferrite for this composition) and the quenching temperature, at which the normal process of growth of pro-eutectoid material was suddenly interrupted. As will become more apparent in the later specimens, it can be seen that even near the germinative point the ferrite separates in small isolated masses showing no disposition to segregate at the austenite grain boundaries when these grain boundaries do not contain any producers of oxidizing gases such as slag inclusions—an important reservation to which I will return later in this series of articles. The random location of the first appearing ferrite is all the more impressive when Fig. 1 is compared to Fig. 2 from Howe and Levy[3], which shows excess cementite extruded to a true meshwork at crystalline boundaries. Howe and Levy's metal contained 1.45 per cent C, 0.16 per cent Mn. It was heated under borax in a graphite crucible in an injector gas furnace for 50 min. to 1,200 deg. C., then transferred to a bath of fused KCl + NaCl at 930 deg., contained in a 4.5-in. graphite crucible held in an electric tube furnace. This temperature then was slowly lowered, taking 9 min. to pass from 960 deg. C. (above the germinative temperature) to 885 deg. C. (below the germinative temperature), at which latter point it was water-quenched, then reheated to 400 deg. C. to sorbitize the martensite ground mass. Apparently the conditions of formation allow close comparison of the crystalline habit of the pro-eutectoid constituent.

Quenching my steel at 720 deg. C. allowed the process of segregation to develop under normal conditions for a much greater interval. As shown in Fig. 3, the ferrite accumulates about nuclei of crystallization representing low-carbon localities and certainly not in characteristic contours surrounding granular kernels where, as a matter of fact, by the inhomogeneity of the solid solution, the last-solidifying material is *highest* in carbon. Instead, the ferrite crystals maintain an individual isolation, from which, however, there appears an incipient formation of acute projections due to the plate-like habit of α iron (in turn responsible for Widmanstättian structure, and the needle-like ferrite often observed in unannealed forgings, as discussed at some length in the article mentioned in the second paragraph

[2]All micrographs are etched with 5 per cent picric acid in ethyl alcohol except Fig. 8 which is etched with HNO_3 in amyl alcohol.

[3]"The Life History of Pro-Eutectoid Cementite." International Congress for Testing Materials, 1912, vol. 2, p. 1.

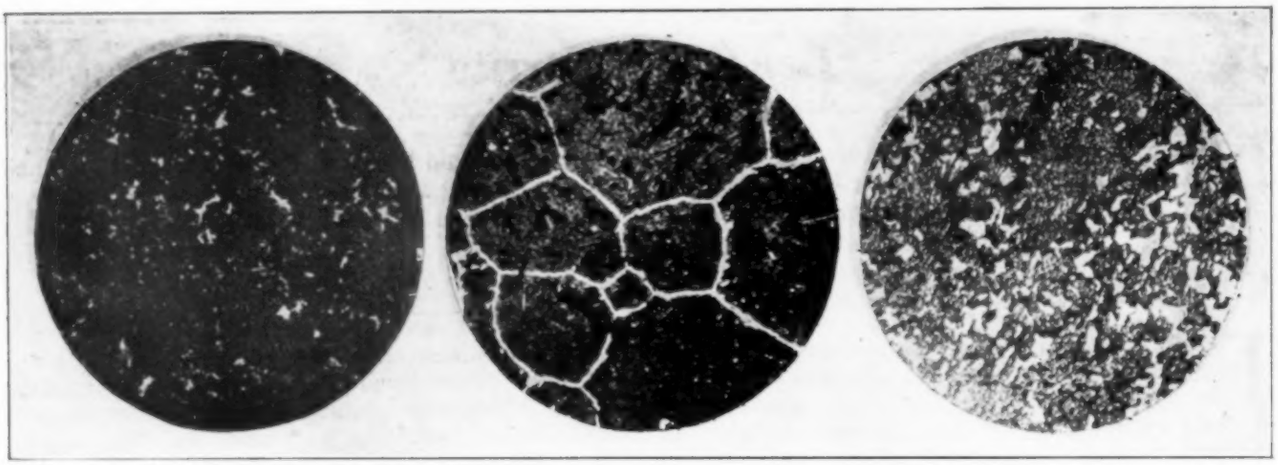


FIG. 1. Ferrite nuclei in 62-point carbon steel; quenched from 730 deg. C. × 160

FIG. 2. First precipitated cementite in 1.45 per cent carbon steel. × 50. (Howe and Levy)

FIG. 3. Ferrite nuclei, after further growth; quenched from 720 deg. C. × 160

of this paper). In this particular steel the first iron to precipitate came down as β iron, above the range MO of the iron:carbon diagram, at low-carbon spots containing considerably less carbon than the average analysis. On further cooling past the beta to alpha transformation, excess iron is precipitated as ferrite with its characteristic plate-like crystallization. Left to itself, such ferrite would appear in a rectilinear meshwork much like the warp and woof of woven cloth, but it is subjected to the additional attraction exerted by the pre-existing nodules of precipitated iron[1]. Its final form therefore is the resultant of these two forces —its own lamellar crystallinity, and the attraction of pre-existing accumulations of ferrite—and at the end the appearance is that of rough approximation of cell walls, much interrupted in their continuity.

Examination of Fig. 4 (quenched from 710 deg. C.) substantiates more clearly the above deductions. Here again are nuclei of ferrite, with their characteristic acute protuberances, but developed in size and distinctness owing to the longer interval of growth. Examined less in detail, but in general aspect, the disposition of the structural elements is such that the ferrite is placed in a manner to simulate the elements of a meshwork *with interrupted meshes* surrounding troostite-sorbite grains but partly isolated, an appearance more striking when examined at lower magification (Fig. 5).

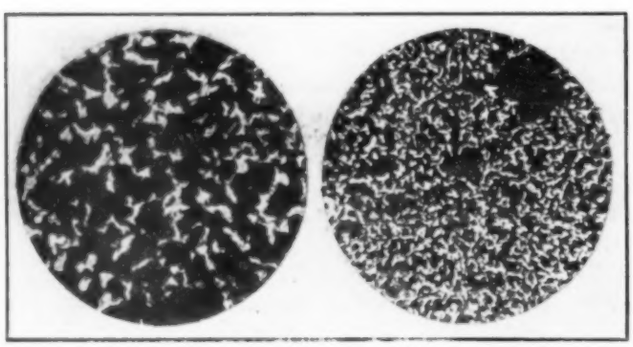


FIG. 4. Semblance of ferrite meshes in 62-point carbon steel; quenched from 710 deg. C. × 110

FIG. 5. Same steel as shown in Fig. 4, but at lower magnification. × 35

[1]That existing ferrite (or cementite) has a pronounced attraction for smaller quantities of nearby like material, even causing an apparent migration of 0.1 or 0.2 mm., is shown in my book on "The Cementation of Iron and Steel," when discussing the reasons for the presence of broad pearlitic zones in steels having a hypereutectoid case (Type II).

Further demonstration of the actuality of such "pseudo-meshwork" is unnecessary, considering the method of its birth—which has just been minutely analyzed—and the fact that the lighter areas are essentially and always have been separate granular crystallites. Furthermore, wide spaces always separate the elements of ferrite, which as a whole present extreme dissimilarity to cementite shells, which I admit are extruded to crystalline boundaries.

Continuing the passage through the transformation range will only cause ferrite grains to increase in size and develop their spinelike fringes, an inference confirmed by Fig. 6, quenched at 700 deg. C. A lower magnification (Fig. 7 at 70 diameters) shows the meshwork appearance to have progressed further, but to retain still its necessary genetic characteristics.

CONFIRMATION BY REVERSING THE EXPERIMENT

Entirely analogous results should be obtained by inverting the process, which can be handily done by quenching—after cooling to some definite temperature between Ar_2 and Ar_1—a partially cemented steel piece whose carbon content increases uniformly from about 0.30 to 0.80 per cent. This is evidently equivalent to fixing for examination in a single specimen a continuous variation in the time and temperature interval between beginning of ferrite deposition and its interruption.

The low-carbon edge of such a carburized steel is shown in 70-diameter microsection in Fig. 8. Originally it possessed

	Per Cent		Per Cent
C	0.19	S	0.03
Mn	0.52	P	0.03
Si	0.11		

and was cemented for 3 hr. at 1,000 deg. C. with CO and wood charcoal, allowed to cool slowly, reheated for 1 hr. at 900 deg. C. in a salt bath, cooled in the pot to 720 deg. C., quenched in water at room temperature, and finally tempered in a lead bath at approximately 575 deg.

Without repeating in detail the preceding discussion, it suffices to note that the structure as one proceeds from the high-carbon to the low-carbon regions develops all the characteristic facts established in what goes before. Low-carbon regions show wide markings of ferrite, resulting from an accumulation of roundish grains, while as the carbon increases, simultaneously appear more and

more suggestions of needle-forms (intersections of the plane of polishing with a plate or sheet of ferrite.)

That hypo-eutectoid steel slowly cooled through the transformation range contains an aggregation of disoriented crystalline granules of ferrite having forms resulting from the play of two different crystallizing tendencies is confirmed in almost daily observation by those working with such steels. One or two very definite instances may be cited.

Fig. 9 shows at 40 diameters the structure near the decarbonized edge of a 12-ton ingot of high-grade steel analyzing

	Per Cent		Per Cent
C	0.55	S	0.018
Mn	0.58	P	0.04
Si	0.26		

On account of a breakdown in the forge shop, the ingot remained in the heating furnace for four days at a temperature of about 1,150 deg. C., then was slowly cooled in ashes. Consequently, primary austenite was thoroughly well equallized in its carbon content during the long heating, and ferrite was allowed to segregate freely in the slow cooling.

Examination of the micrograph shows clearly in each ferrite crystal the morphological characteristics resulting from its habit and birth. Large masses of carbon-free material have formed near the decarburized region at the ingot surface. The sharp discontinuity at the inner surface of the carbon-free shell is but another exhibition of the strong tendency of insoluble material to collect about pre-existing masses of the same substance.

In later phases of segregation the individual crystallites have continued to place themselves side by side, constituting a chain-like ensemble imitating the threads of a mesh. The history of this ingot and the presence of large isolated ferrite masses preclude the separation of excess iron at austenite borders. The fact that no disturbing forces set up by slag inclusions were present in any of the steels experimented upon should, however, again be emphasized.

Another example of the separate morphology of β and α iron is shown in Fig. 10, at 65 diameters. This is from a 7-ton nickel-steel ingot for a gun-tube containing

	Per Cent		Per Cent
Ni	1.98	S	0.007
C	0.43	P	0.021
Mn	0.42	Si	0.22

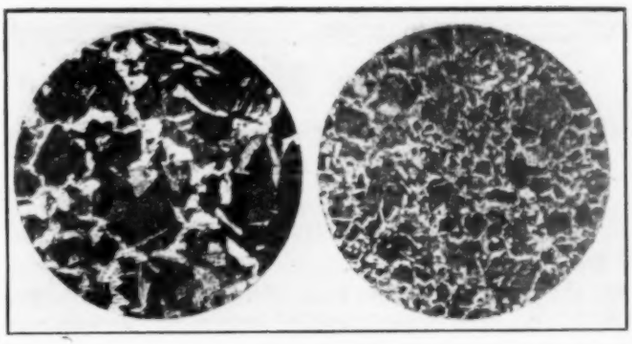


Fig. 6. Interrupted meshes in 62-point carbon steel; quenched from 700 deg. C. × 110

Fig. 7. Same steel as shown in Fig. 6, but at a lower magnification. × 45

which had been extremely carefully made and had undergone a heat treatment analogous to that just discussed. Further discussion of its obvious interpretation would be tiresome.

Conclusion

To summarize: The formation of the mesh-like structure in slowly cooled hypo-eutectoid steels is a fundamentally different phenomenon to that of the formation of the cementite shells in hypereutectoid steel, a conclusion in every way in accord with the well-known process of formation of non-homogeneous austenite from the molten metal. Whereas cementite actually segregates in sheets at the high-carbon interfaces between crystals of primary solidification, ferrite begins to separate in isolated masses in the central regions of austenite crystals at or near the points where the austenite began growing from the mother liquor, and where, subsequently, lacking the necessary heat treatment for perfect diffusion, the carbon must necessarily be lower than in its immediate surroundings. Only in the later progress of the segregation of insoluble ferrite do meshes appear resulting from the development of characteristic elongated fringes of α ferrite. This plate-like development of α iron is facilitated to an extent in direct proportion to the gradual disappearance of local variations in carbon concentration in the mother crystal. Thus long annealing gives a uniform diffusion and a more evident plate-like habit of α iron. Widmanstättian structure highly developed in coarse meshes is logically the end of the series as uniform austenite is reached.

Fig. 8. Ferrite growth completely revealed in cemented steel.

Fig. 9. Ferrite phenocrysts at decarburized surface of ingot. × 40.

Fig. 10. Pseudo meshwork of ferrite in nickel-steel ingot. × 65

Legal Notes

By Wellington Gustin

Law Regulating Contracts for an Approximate Amount Such as the Output for a Season

Does contracting the output of a plant or factory put the party under the legal obligation to operate the factory or plant under peril of breaching the contract for which he is liable in damage? What will the courts read into such a contract? What excuses may the party set up to relieve himself of responsibility? What is the meaning given to "season's output," "entire output," etc.? The answers to these problems may be found in the court decisions following:

Case of Kenan, McKay & Spier vs. Yorkville Cotton Oil Co.

In the latest case on the subject, Kenan, McKay & Spier, a Georgia corporation dealing in cotton linters, brought an action against the Yorkville Cotton Oil Co., a South Carolina corporation, in the Federal District Court, for breach of contract between the parties. By the contract the Cotton Oil Co. sold its "season's output of cotton linters, about 400 bales." It was said in the oil mill business the season began with August and closed with July, but it seems the period of active operations during which the most of the available seed is consumed covers only four or five months. It appears that the cotton oil company started up its mill in September and kept it running until the latter part of November, when it was closed down. In that time it turned out 155 bales of linters, all of which were delivered to the plaintiff dealer and paid for according to the terms of the contract. With the last shipment the cotton oil company wrote the dealers that owing to inability to borrow money for operating purposes it was forced to close down its mill for the season.

Upon objections to this action from the dealer the cotton oil company wrote the following: "We have shipped you our entire output, and, should we resume operations this season, we will ship you any further linters we make. We have nothing to add to this, and from our standpoint it closes the matter."

Following this letter the dealer brought suit in the state courts of South Carolina. Here a judgment against it was appealed to the Supreme Court of the state, and the judgment there affirmed. This court held that the cotton oil company was not bound to operate its mill in order to make the estimated quantity of linters, and that its obligation was discharged by the delivery to the dealer of all the linters actually produced. On the point the court said: "The buyer is bound to take the output, because he agreed to that. The seller is not bound to furnish more than the 'output,' because he has only agreed to furnish that much."

Losing on its point in the state court and there being a diversity of citizenship in the parties, the dealer brought the action in the Federal court. A judgment for the cotton oil company in the District Court was appealed to the Circuit Court of Appeals. (260 Fed., 29.)

This latter court said the complaint in this suit alleges bad faith, but there was nothing in the record to sustain it. Instead there was convincing and undisputed testimony that persistent efforts had been made by the cotton oil company to do business. The mill shut down solely for lack of money to keep it going. It appears that the company had little or no working capital, that its own borrowing power was exhausted, and that it had no assets with which to secure advances. It could not go on without ready money, and its inability to borrow was admitted. In this helpless condition it could not do otherwise than suspend operations, and hence it does not show lack of good faith in closing down the mill, said the court. Without showing lack of good faith on the defendant's part it cannot be said to have breached its contract.

Further the court said other facts seemed conclusive in themselves, in that the commercial products derived from the process of crushing cottonseed are oil, meal, hulls and linters, and the value of the last named product is barely 10 per cent of the whole. Hence it is not supposed that the defendant would go out of business in order to avoid the comparatively small loss on its contract with the dealer. Therefore the judgment of the District Court was affirmed.

Home Fertilizer & Cotton Oil Co. Case

The Supreme Court of Alabama was called upon to decide the point in a similar contract between plaintiff herein and the Home Fertilizer & Cotton Oil Co. (79 So., 367.) There the court said: "It is not possible to imply an obligation to make an article from an assumption of the limited obligation to sell, not a definite number of an article, but simply merely what the seller makes. . . . The seller having acted upon the buyer's promise to take his output, the buyer becomes bound to take what the seller has made, in reliance upon the buyer's promise, and the seller becomes likewise bound to deliver the output of his plant."

Case Between Plaintiffs and Dawson Cotton Oil Co.

In still another case, against the Dawson Cotton Oil Co. the latter was charged with shutting down its mill wrongfully and in bad faith for the purpose of evading its contract obligation. Of course, under such a condition there would be a breach of contract. However, the Court of Appeals of Georgia took occasion to say: "Of course, had the defendant discontinued the operation of his mill for some providential cause, or for any cause or causes not in any wise attributable to it, a delivery on the part of the mill of its output up to the time it ceased to operate would be all that the law would require."

Case of Brawley Against the United States

In the case of Brawley against the United States (96 U. S., 168) the U. S. Supreme Court said:

"Where a contract is made to sell or furnish certain goods identified by reference to independent circumstances, such as an entire lot deposited in a certain warehouse, or all that may be manufactured by the vendor in a certain establishment, or that may be shipped by his agent or correspondent in certain vessels, and the quantity is named with the qualifications 'about,' or 'more or less,' or words of like import, the contract applies to the specific lot; and the naming of the quantity is not regarded as in the nature of a warranty, but only as an estimate of the probable amount, in reference to which good faith is all that is required of the party making it."

Manufacture of Carbon Electrodes for Electric Furnace Purposes

A Description of the Raw Materials Used and Their Preparation, Calcining Furnaces and Plant Operation in the "Rammed Process" of Manufacturing Electrodes for Electric Furnace Purposes, With an Outline of Practical Deductions Obtained From Experimental Data

By WALTER L. MORRISON

CARBON electrodes for electric furnace work are divided into two classes: The graphite and the amorphous carbon electrodes. The amorphous carbon electrodes are again subdivided into two or more groups, depending on the process used in the manufacture. The method of manufacture covered in this paper is the so-called "rammed process" for the manufacture of electrodes.

The electrode is formed by ramming or pressing the material in a mold. The electrode after removal from the mold is allowed to cure, then is placed in a calcining oven and baked to remove the volatile matter. The raw materials used consist of carbonaceous products, and some form of binder such as tar and pitch.

Raw Materials

Pitch. The pitch used in the manufacture of amorphous carbon electrodes should be of the coal-tar variety, clean and of the highest quality. The pitch should contain at least 40 per cent fixed carbon, and the coke residue should be dense and tough. The so-called crude oil pitches and asphaltum pitches are not suitable for the manufacture of electrodes.

Coal-tar pitch is readily distinguished from the asphaltum pitch by odor or taste. A still better test is to volatilize a small portion of each in a crucible; the coal tar leaves a heavy, dense coke, while the asphalt leaves a very porous and friable coke, from which it is very hard to drive the last traces of volatile. Temperature during volatilization should not be too high; a good grade of coal-tar pitch loses nearly all its volatile matter at about 600 deg. F., while the asphaltum loses the last trace at a much higher temperature. The grade of coal-tar pitch used is that having a melting point from 150 to 200 deg. F.

The liquid tar used is also a coal-tar product. This material is the common unrefined product, having a fixed carbon residue of 25 to 35 per cent. This tar should be thoroughly dried before using to remove moisture. The coke residue is very similar to that of the solid coal-tar pitch, being dense and tough.

Coal. Anthracite coal is one of the best materials we have for the manufacture of amorphous carbon electrodes. This material is very dense and remains more or less so after calcination; especially is this the case with coals having a low volatile content.

The coal should be of the highest grade obtainable, high in fixed carbon, low in ash and as free as possible from other impurities. The fixed carbon should run 80 per cent or better and the ash should be under 5 per cent, preferably under 3 per cent. The writer has used coals running as high as 10 or 12 per cent with good results. When using inferior coals it is a good plan to mix some other suitable carbonaceous material of low ash content, such as petroleum carbon, or high-grade graphite, to lower the total ash content in the electrode.

Coke. The ordinary coke is not an essential material in the manufacture of large electrodes. Many attempts have been made to use the so-called petroleum or carbon residues from the manufacture of gas in which crude oil is used. Properly prepared petroleum coke works out very well in connection with anthracite coal.

The so-called petroleum carbon, which is very similar to lampblack, but having a higher volatile content, is extremely fine and porous. When a binder is mixed with this material, it absorbs such a large quantity to make a suitable mixture which will ram that on calcining the electrode will check. The electrode also has a tendency to spall when placed in service.

Foundry coke has been tried, but this material is so porous and of such high ash content that the conductivity is very low compared with other materials available.

Graphite. Graphite is an ideal material for the manufacture of electrodes, but unfortunately nearly all the natural graphite is so impure that it would have to go through a refining process, which would prohibit its use in an article which sells so cheaply as electrodes.

The artificial graphite is about the only solution of a graphitic material for electrode manufacture. However, experience has shown that the electrode made up from graphitic materials does not have as high an electrical conductivity as the amorphous carbon electrode which is subsequently graphitized, for example the Acheson electrode.

Much of the coal in the electric calcining process is converted into graphite, which adds greatly to the life and conductivity of the electrode. The graphite resists oxidation much more than the amorphous carbon.

Preparation of Raw Materials

Tar and Pitch. The tar and pitch are used in the molten state. The tar is heated in a large tank by means of a steam coil or steam jacket, to remove all traces of moisture and the lighter volatile oils. If this is not done but the tar added to the hot pitch without drying, it will cause the pitch to boil and perhaps take fire.

The ratio of tar to pitch depends a good deal upon conditions, the size of electrodes and equipment. Too large a quantity of tar should not be used, as the electrodes will not stand handling while warm in the green state. If all pitch be used, it makes the mixture too stiff to work properly or produce a uniform electrode. An all-pitch binder leaves the electrode extremely brittle while in the green state and is liable to break during the

cooling or curing. The temperature of the building has some influence upon the ratio of tar to pitch. During the winter months a higher ratio of tar should be used than during the summer months, unless the buildings are heated or are equipped with warming ovens or pits.

The fixed carbon or coke residue in the tar and pitch mixture should range between 30 and 40 per cent. The writer has obtained the best results with a mixture running 35 to 40 per cent fixed carbon. This is equivalent to one part tar to two or three parts pitch.

The tar and pitch are mixed in a large vat and kept molten by means of a steam coil. A measured quantity is then added to the ground carbon, which has been previously heated, and the whole mixed thoroughly.

Calcining Coal and Other Carbonaceous Materials. The purpose of calcining the raw materials is to lower the volatile content, thus preventing undue shrinkage, and check or mud cracks in the finished electrode.

There are several ways in which the calcination may be effected, viz., retorts, ovens, tubes and electric-resistance furnaces.

The main essential is to keep the material during calcination and subsequent cooling away from the air, as any oxidation raises the ash content. Also to carry the heat high enough to bring the volatile matter below 1 per cent, best results are obtained when the volatile is near 0.5 per cent or under.

The temperature necessary to carry out this operation is at least 1,300 deg. F., and preferably above 1,500 deg. F. The entire mass should be subjected to this temperature and results checked by pyrometers in the mass. Analyses should also be made from time to time in order to have the material under control and in the proper condition before going ahead with the process of manufacture. One of the best and most efficient methods of calcining is the use of the electric-resistance furnace.

Coal Calcining Furnace

There are two types of electric-resistance furnaces which are commercial, the vertical and the horizontal. The horizontal type is an intermittent furnace, being similar to the carborundum furnaces. The vertical resistance furnace is a shaft furnace and operates continuously. The coal is fed in at the top and after calcination removed from the bottom. The furnace is usually 20 to 40 ft. in height by 4 to 6 ft. in diameter. An iron shell of the proper dimensions is used. The upper part, in which the calcination takes place, is lined, while the lower part is unlined, to allow the cooling of the calcined mass before removal from the furnace, to prevent undue oxidation.

The current or kw. input into the furnace is regulated by drawing calcined coal from the bottom of the furnace, when the current becomes too high. This allows green coal to move down, thus increasing the resistance of the mass between the two electrode terminals.

Green anthracite coal has a very high electrical resistance, but as the volatile matter is removed the resistance drops very rapidly. The furnace works very satisfactorily, and with slight variation of current. The power consumed per ton of coal varies from 360 to 750 kw.-hr. depending on size of the installation and the amount of graphite produced.

There are two types of shaft resistance furnaces which can be used. One has two rings of carbon insulated from the shell and acting as electrodes to carry the current. The electrodes are spaced from 2½ to 5 ft. apart, depending on the voltage used. When operating with this type of furnace it is of advantage to have a transformer with several different taps to vary the voltage. The most desirable voltages would be 409, 609, 809, 1,009, the lower voltages being used for regular operation. The furnace has to be started with a good conducting carbon material. The upper part of the furnace is lined with a non-conducting material, with the exception of the carbon rings.

The other type of shaft furnace has an upper and lower central electrode. The lower electrode is fixed, the clamp and terminals being protected from the descending hot materials.

The upper electrode is movable and therefore allows a wider range of regulation, particularly when there is only one voltage available.

The calcination of coal requires a heavy current and low voltage. In normal operation the voltage should not exceed 60 volts, except in very large furnaces, to obtain the best results. The current density in the shaft between the two electrodes should be 5 to 10 amp. per sq.in. sectional area of shaft. This type of furnace has been developed to use with fine coal, the so-called slack, which is obtainable at a very low figure. This furnace will not work as satisfactorily on the lump coal as the furnace with the ring electrodes, on account of the more or less restricted openings in the shaft due to the central electrodes, which cause hanging in the shaft and irregular working conditions.

If fine slack or coal is used with the ring electrode furnace, the electric current has a tendency to pass so close to the lining as to cause a gradual reduction and deterioration of the lining by the excessive heat. This condition necessitates very frequent repairs, besides giving a poorer quality of coal when conditions get very bad. If the current be forced through the center of the mass, the excessive heating in the middle of the coal does no harm but is really of benefit, as it promotes the formation of large quantities of artificial graphite.

The calcining furnace during operation should be under laboratory control, frequent analyses being taken, to determine the status of the operation and detect any irregular working of the furnace. The best practice is to take at least one sample from each shift. A recording ammeter is also very useful to check up the furnace operation.

Construction of Molds and Dies

The design and construction of molds depends upon the process used in the manufacture. In the making of plain rammed electrodes which are not subjected to pressure other than the ramming, a split mold is used, which is constructed of light casting or heavy boiler plate reinforced with angles and held together with bolts. After the mold is rammed, the bolts are loosened and the electrode is removed. The electrodes made in this manner are those of special shapes: the square, hexagonal, etc., which are used without nipples for joining together. They vary in length from 6 to 9 ft. The electrodes which are not subjected to pressure after ramming are not nearly as good as the others. The split mold is not strong enough mechanically to withstand much pressure, such as is given the electrodes made in the one-piece mold.

The solid mold is of heavy construction and slightly with a binder, consisting of pitch and tar. The amount of taper from $\frac{1}{16}$ to $\frac{1}{32}$ in. per ft. on the diameter of the mold. The thickness of the walls is more or less an arbitary matter, since the material being subjected

to pressure does not act as a liquid nor as a solid. Furthermore, if the mold was designed to resist the pressure of a fluid and figuring on the pressures which are used, it would mean the use of an extremely heavy casting, which would be troublesome to handle. We usually figure from one-fifth to one-third the thickness required for a fluid, allowing a good factor of safety. The mold is made from 12 to 20 in. longer than the finished electrode desired.

The dies forming the female thread on the ends of the electrodes have a very low pitch and shallow thread. The diameter of the thread or nipple is approximately half the diameter of the electrode with which it is to be used. The pitch on the 18- to 24-in. diameter electrodes runs about one thread in 2 in., depth of thread $\frac{3}{4}$ to 1 in. There should be ample clearance for the nipple in the female thread, at least $\frac{3}{16}$ in., to allow for any blistering or slight imperfections which may occur either on the nipple or in the female thread during baking. The nipple can be made up in a heavy cast split mold which has been properly machined.

The dies forming the female threads in the ends of the electrode, after the mold comes from the press, are removed by screwing them out.

Calcining Furnaces for Electrodes

The large electrodes are so heavy and of such length that it is necessary to bake them on end. This requires the use of saggers, iron tubes, or a specially constructed furnace with chambers constructed very much like a large vertical muffle. The furnace should be so constructed as to obtain a uniform temperature throughout the entire length of the electrode. Pyrometer openings should be placed in several parts of the furnace, as well as in the retorts, to have proper control of the furnace.

Gas, oil or powdered coal may be used for firing the calcining furnace. The retorts or chambers should be large enough to allow at least 2 in. of packing material on all sides of the electrode.

Mixing

The calcined raw materials are ground so as to form a compact mass. This is best done in a dry pan, the material all passing through a screen. After grinding and sizing, the different sizes are warmed and mixed with a binder, consisting of pitch and tar. The amount of binder added varies from 15 to 20 per cent, depending on the kind and grade of materials used. There should be just enough binder to make the material adhere when molded into a ball with the hands. It is advisable to treat the mixture in a hot wet pan, to work out the air and get the tar completely worked around the particles of coal and petroleum coke. The mulling operation should require from 12 to 20 min., in order to make the toughest and most compact mass. If during the mulling the mass should become too dry, then more tar should be added. After some experience this is readily told by inspection. Too much tar should be avoided, as it causes undue shrinkage of the electrode and causes an excess pressure to be exerted on the electrode mold during squeezing, because the material has a greater tendency to flow under pressure and approaches the property of a fluid.

The pan should be sufficiently hot to keep the mass in a plastic condition; otherwise, when ramming, cavities are apt to exist in the electrode, also there is an imperfect bond between batches. The pan and rolls may be kept warm by means of a small gas or oil flame, and in no case should the pan or rolls be hot enough to volatilize the tar. The tar begins to boil or volatilize at about 500 deg. F. In making up the mixture for the nipples it is necessary to add a somewhat larger amount of tar, in order to produce a perfect thread. This is more or less a matter of experiment to determine the exact amount necessary, as conditions vary from time to time. After mixing thoroughly the material is placed in a mold for ramming.

Ramming

For the purpose of ramming, a bar or rod with an iron shoe secured to the end works up and down in the mold, the action being very similar to that of a stamp in a stamp mill. On the downward stroke you get the full weight of the stem and shoe. In designing this type of ram one must take into consideration the fact that the mold is constantly filling up. This calls for a special design other than the ordinary ram.

In order to maintain a constant height of drop as the mold fills up, a rack is placed on the stem and a pinion gear engages the rack, the pinion gear having several teeth omitted to allow the drop of the stem. Thus the height of drop will always be the same and can be varied by changing the size of pinion.

Another very simple ram is one having a round shaft with a shoe on the end and passing through two guides, a cable being secured to the other end. The ram is operated by a long-stroke double-acting steam cylinder, the slack and adjustment being taken care of by a small winch.

The shoe is specially constructed, having a tapered top to allow for passage of material and to be kept clear. The size and shape of shoe depend upon the electrode to be made. There should be a clearance of 1 to 2 in. between the ram and the sides of the electrode mold, for the passage of the carbon and pitch.

The mold is first warmed, then the inside surface oiled, the lower die placed in position, and the mold placed under the ram.

Material to a depth of 8 or 10 in. is placed in the bottom of the mold, then the ram is started. One man shovels in the mix while the ram is working. The shoes on the bottom of the ram have large conical points to prevent the formation of a joint in the electrode mass. After the mold has been rammed full, if the electrode is to be pressed, the mold is placed on a car, the upper die is placed in position, and the car is then moved to the press.

Pressing

The bottom plate of the electrode mold has an opening large enough for the passage of a die fastened to the plunger of the press. The electrode is subjected to pressure in three steps:

First, pressure is exerted on the bottom of the electrode, with the top of the mold resting against the top or upper platen of the press. This initial pressure is to allow sufficient space at the bottom of the mold for the removal of the electrode, or rather freeing from the sides of the mold in the last operation.

Second, an iron bushing of smaller diameter than the electrode is placed on the upper die, bearing on the upper platen when pressure is resumed. This exerts pressure on the top of the electrode as well as the bottom. During this second operation pressure is exerted on both ends to a maximum for the operation, and varies from 100 tons for an 8- or 10-in. diameter electrode up to 500 tons for 20- or 24-in. diameter electrode. These

represent the total pressure on the full cross-section of the electrode.

Third, pressure is exerted on the top of the electrode only, the mold resting on a plate. This loosens the electrode in the mold, as the mold is slightly tapered for this purpose. The pressure for this operation should not exceed that used in the second operation. If it should, the electrode must be sticking in the mold, due either to the use of too much tar or a careless oiling of the interior of the mold, or starting with the mold too hot, or a combination of these causes. The electrode should be of such composition that a hard, tough skin exists on the outside. When the electrode has become loosened, the mold is removed from the press, picked up by the crane and lowered into the pit. The bottom plate is removed, and the mold skinned off the electrode by hoisting the mold. In a short time the electrode is firm enough to withstand handling, is taken to the calcining oven, and packed for calcining.

Calcining

The electrodes are placed on end and packed in carbonaceous material, which is more or less porous to allow passage of the volatile gases from the electrodes. The material should be placed firmly around the electrodes, and they should also be covered to some depth.

The firing should proceed slowly, and after attaining a temperature of 600 deg. F. the furnace should be held at this temperature from two to four days depending on the size of the electrodes. This allows for the removal of the greater portion of the tar, which comes off slowly at this point, without injuring the conductivity of the electrode. The temperature may then be raised gradually up to 1,300 or 1,400 deg. F. and held at the upper limit till the coolest point of the furnace has reached 1,300 deg. The firing period requires usually from seven to ten days. The furnace is then cooled down, taking four to six days, making the total period of calcination fourteen to sixteen days.

If the temperature is raised too rapidly and before the volatile is removed from the electrode, the violent volatilization of the tar often causes fractures and splits, and very often a honeycomb structure which impairs the electric conductivity.

Surface checks on the electrodes are caused by poor mixing, high volatile content in raw materials or improper calcining. A few surface checks as a rule do not impair the electrical properties of the electrode.

Experimental Data

Electrodes having a high volatile content are not serviceable for electric-furnace work. The lower the volatile matter in the finished electrode, the better the performance in the furnace.

Electrodes were made from the so-called gas-house carbon, but these were found to be very unsatisfactory. In the first place, the carbon is so extremely fine it is like a sponge and absorbs large quantities of pitch before it is workable. After the molding operation it is very difficult to remove the electrode from the mold, as it has little mechanical strength and will hardly support its own weight. During the baking of the electrode the shrinkage was so bad as to cause large transverse cracks. The volatile in the finished electrode was also very high. The last of the volatile is very hard to remove and this is a property peculiar to all products derived from petroleum.

It has been suggested to make briquets of the gas carbon, using a pitch binder, and burn these at a very high temperature to form solid pieces of material as a base, which is subsequently crushed and sized and forms a basis for electrode material. This works out fairly well, but is very expensive, and makes the cost of the finished electrode much higher than when using other materials which have a better structure. The only reason for using the gas-house carbon is on account of its purity and its low ash content. For certain electrochemical work where a very pure electrode is required, it may find a use, but for ordinary smelting operations it is out of the question, on account of the cost of handling this material.

In preparing the coal for electrode manufacture, many different methods of calcination were tried and we finally resorted to the electric calcining furnace, which gave us a calcined coal running under 0.5 per cent volatile.

The first calcining operations of the electrodes were carried out by packing the electrodes in a horizontal position on a large hearth, using crushed coke, and covering the coke with mud to prevent oxidation. Several of the electrodes were lost due to transverse cracks and in some cases were completely severed during calcination.

The next batch of 10-in. electrodes was packed in 14-in. iron tubes and stood on end in the furnaces. All the electrodes came out without any breakage losses.

A furnace was then constructed with six chambers 25 in. x 56 in. x 10 ft. deep, using firebrick construction. These chambers were designed to hold 17-in. diameter electrodes x 8 ft. long.

Firing is done along the sides of the chambers, and works out very satisfactorily. Particular attention must be paid to the firing, and the success of this final operation depends upon the first four days' firing. During this period the temperature of the electrode chamber should not exceed 650 deg. F.

The shrinkage of electrodes during calcination is not very great in the case of rammed electrodes, and varies to a more or less extent, depending on conditions, as to mix used, total pressure used in ramming, and calcining. However, this is not such a vital point in the manufacture as the electrical conductivity, behavior when subjected to sudden changes of temperature and resistance to oxidation during service.

Many protective coatings have been tried to prolong the life of the electrode in service, but the writer has not found or heard of anything which works out very satisfactorily in furnace operation.

Portland, Ore.

British Output of Iron and Steel in 1919

The National Federation of Iron and Steel Manufacturers has issued the following return of the output of pig iron and steel in the United Kingdom during 1919. The figures are based upon returns, collected by the Federation, which, for the month of December, cover 93 per cent of the output in the case of pig iron and 96 per cent in the case of steel ingots.

Months	Pig Iron Tons	Steel Ingots Tons	Months	Pig Iron Tons	Steel Ingots Tons
January	664,000	718 000	September	574.000	718 000
February	625.000	734 000	October	445.000	438 000
March	684 000	758 000	November	630,000	693 000
April	653 000	668 000	December (approximate)	640,000	680 000
May	662,000	755,000			
June	612,000	631,000			
July	660 000	618 000	Total, 1919	7,370,000	7,885 000
August	521,000	474,000	1913	10,260,000	7,664 000
			1918	9,072,000	9,591,000

Technical Application of Hydrogen in Hydrogenation or Hardening of Oils

Principles Involved in Saturating Unsaturated Oils by Hydrogenation — Commercial Adaptability of the Method to Industrial and Edible Oils—Technology of the Process and a Schematic Outline of the Apparatus Used

By HARRY L. BARNITZ
Consulting and Construction Engineer

A VERY extensive use of hydrogen has developed in connection with the fat industry. By the introduction of hydrogen into fatty bodies and oils of low melting point these are converted into hard fats of higher melting point. In other words, oils which are composed of unsaturated acids, such as oleic acid and their esters, will combine with hydrogen in the presence of a suitable catalytic agent, forming a saturated compound

$$C_{17}H_{33}COOH + H_2 \rightarrow C_{17}H_{35}COOH$$
oleic acid + hydrogen → stearic acid

Fatty vegetable and animal oils may be described as consisting of a glycerine part and an acid part. The composition of the glycerine part is constant. The composition of the acid part varies from oil to oil, and is characteristic of any one oil, or of any one group of oils.

Several important vegetable and animal oils contain an acid part having the general chemical formula $C_nH_{n_2}O_2$. Among these we have cocoanut oil, palm oil, palm kernel oil, butter fat, lard, tallow, and various "butters" such as cocoa and mace butters. These oils and fats are characterized by the possession of a thick consistency; that is to say, they have high melting points, or, generally speaking, they are naturally "hard."

A considerable number of important vegetable and animal oils differ from those just discussed, in that their acid parts fail to correspond with the general formula stated, to the extent of two, four, six or eight atoms of hydrogen. For instance, in rape oil, and certain fish oils, two atoms are missing. Four are absent in the acid parts of cottonseed oil and soya bean oil. In linseed oil six atoms are missing, and as many as eight atoms are lacking in certain liver and blubber oils. These oils are characterized by the possession of a liquid consistency.

Saturating Unsaturated Oils

The acid parts of these oils are termed "unsaturated," for they are capable of picking up and combining with additional atoms of hydrogen. Under normal conditions, hydrogen, even in the nascent state, is quite without action on the fatty oils. To convert an unsaturated oil into a saturated oil has led to much investigation and it has been found that the addition of the hydrogen atoms can be effected if the oil is suitably treated with hydrogen in the presence of finely divided nickel, platinum or palladium. Each of these metals acts as a catalyst, and is left unaltered after the hydrogen has been taken up by the oil.

For the purpose of industry the world's supply of solid fats is deficient, while the supply of liquid oils is superabundant. Solid fats of vegetable origin are especially scarce. The hydrogenation process permits us to make good the deficiency by converting some of the superabundant liquid oils into hard fats.

Hydrogen has another advantage which is in some cases even more important than solidification effect. The saturation by hydrogen of the unsaturated bodies renders the oil much less likely to oxidize and rancidify.

Commercial Applicability of Hydrogenation Process to the Soap Industry

As an instance of the commercial applicability of the hydrogenation process, we may look for a moment at the soap-making industry. Tallow may be said to be the ideal substance for the soap manufacturer to work with, giving the necessary stiffness and texture to soap and yielding a firm soap such as we use daily.

Tallow, however, is expensive, and is obtainable only in limited amounts. Accordingly the soap manufacturer falls back upon some of the harder oils, such as palm oil, palm kernel oil and cocoanut oil. These oils are also expensive and are in increasing demand in other industries. If, on the other hand, the soap manufacturer tries to replace them with one or the other abundant naturally liquid oils, such as soya bean oil or whale oil, his product loses greatly in quality, and is apt to be a soft, sticky mass, unsuitable or unsalable as soap for many purposes. Hardening these oils before using them, he obtains a substance practically identical with tallow without affecting the yield from them of that valuable byproduct of the soap-making industry, glycerine. Therefore the hydrogenation process places at the disposal of the soap manufacturer a wide range of oils which otherwise would be next to useless for his purpose.

These remarks will also apply to the candle-making industry, which also calls largely for fats rather than oils.

Edible Synthetically Hardened Oils

Fats are now in demand for margarine and certain other edible compounds to a greater extent than can be conveniently met from natural sources of supply. It is certain that synthetically hardened oils will soon be extensively used for edible purposes throughout the world.

Great quantities of cottonseed oil at present are hardened. Increasing quantities of fish and whale oil, linseed, soya bean, cocoanut, palm kernel, palm and other vegetable oils are also being subjected to the process.

A word of explanation is no doubt desirable with regard to the hardening of cocoanut oil. This oil is just on the border line between liquid and solid fats, chang-

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ing from a liquid to a solid state with fluctuations in temperature. All its acid part is not saturated, but contains portions of unsaturated acids. It is therefore capable of absorbing a certain amount of hydrogen, and so becoming harder than normally in this climate, but its melting point is not sufficiently raised to meet the requirement of a butter substitute which will stand summer temperature or the high temperature of countries in the torrid zone. To raise the melting point of the hydrogenated cocoanut oil to that required in lard or butter substitutes a small amount of hardened peanut or cottonseed oil is added, therefore contrary to widespread supposition cocoanut oil is not capable of being hardened by hydrogen to any great degree; in no sense comparable with hardening of such oils as cottonseed, soya bean, peanut and oils of this character. Cocoanut oil is almost saturated, as shown by having an iodine number of less than 10, while, for example, that of cottonseed oil is over 100. The iodine number is commonly used to express the extent to which hydrogen has been taken up by the oil in hydrogenation operations.

Characteristics of Hardened Oils

The characteristics of these hardened oils are white, tasteless, odorless substances of tallow-like consistency. They should all be identical, whatever may be the particular oil started with, and in theory and practice such identity seems to be attained, at least in the oils as freshly hardened.

It is customary to harden the oils at the soap works, or wherever else they are to be used or are otherwise employed, with but little interval between being hardened and being treated in industrial processes. The point of importance, therefore, is that certain oils will be hardened before shipment to this country. In the Orient and tropics the process is attracting considerable attention from the cocoanut and soya bean oil producers, the idea being that hardened oils may be shipped and carried without risking loss through leakage, which is a serious item in the shipment of liquid oils for long distances.

The technology of the process is dependent primarily upon two conditions—first, the careful preparation of the catalyst, and, second, the use of very pure hydrogen. A slight variation of procedure may quite readily result in an entire failure to harden the oil.

The catalyst ordinarily used on a commercial scale is metallic nickel prepared in a finely divided state by chemical precipitation. Once made, it must be kept strictly apart from certain other substances, notably air, moisture, sulphur, phosphorus, arsenic, carbon monoxide, chlorine, etc. These substances oxidize or otherwise react on the metallic nickel, and destroy its catalytic action, 0.1 per cent of H_2S being sufficient to destroy the catalytic action of nickel. Certain kinds of fish oils contain sulphur, and if this is not removed before attempting to harden these oils, the sulphur will quickly destroy the activity of the catalyzer. The action of these substances on the catalyst is exercised in three ways. First, it means that the hydrogen used must be very pure and free from moisture and sulphur compounds. Second, the oil to be hardened must be thoroughly free from moisture, which it usually contains when received. Third, in preparing the catalyst a stage is reached when it must be treated and handled out of contact with the atmosphere.

Technology of the Hydrogenation Process

When all the necessary conditions are complied with, the process is not difficult. The oil with the catalyst (usually the nickel catalyzer is employed in the proportion of 40 to 60 lb. per ton of oil) added is heated in an atmosphere of hydrogen inside a closed vessel termed the "converter." The oil and hydrogen are brought into intimate contact and at the end of 2½ to 4 hr. the absorption is found to be complete. The temperature at which the work is carried on is of great importance. For any given pressure of hydrogen inside the converter there is a definite temperature which must be reached before the absorption begins. At atmospheric pressure this temperature appears to be about 250 deg. C. In practice such a temperature would almost certainly result in the hardened oil being discolored. To avoid this, some temperature approximating 200 deg. must be used. The

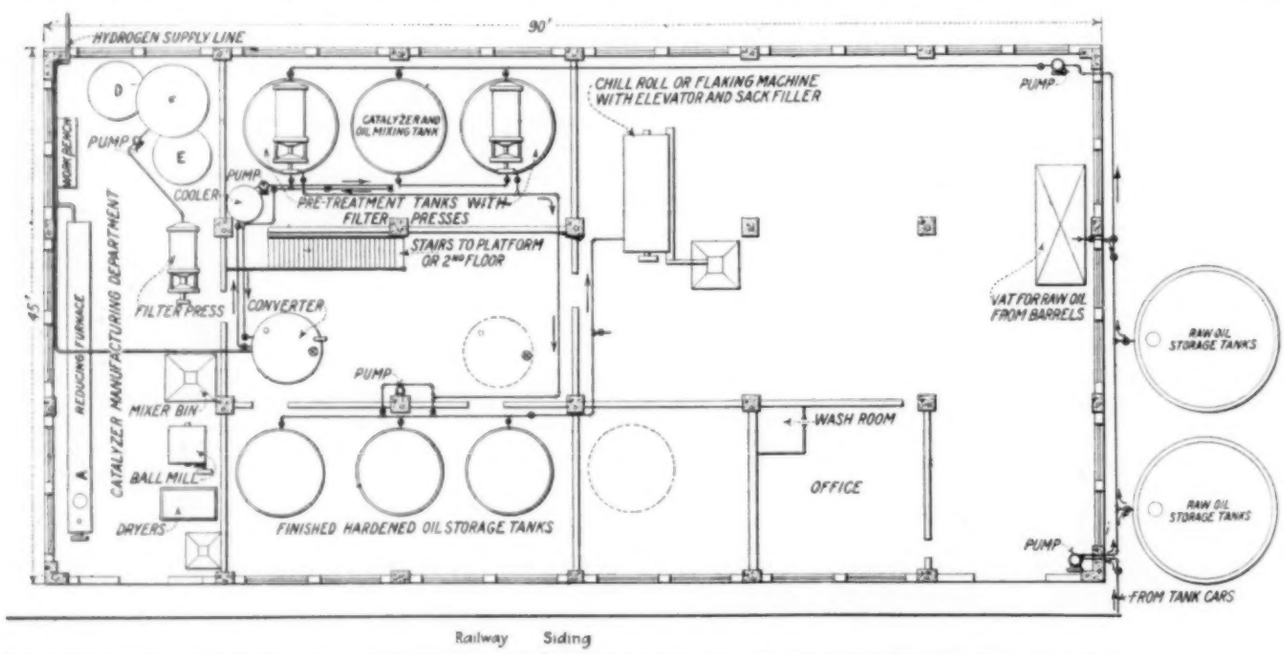

FIG. 1. DIAGRAMMATIC PLAN OF A 1,000 LB. PER HR. OIL-HARDENING PLANT

pressure of the hydrogen has to be increased above atmospheric as the temperature is decreased. A normal working condition is a temperature of 170 to 180 deg. C. in conjunction with a pressure of 70 to 80 lb. per sq.in. When the absorption is complete, the oil is run out of the converter, cooled, filtered, and allowed to solidify. A general diagrammatic plan of a modern oil-hardening plant of a working capacity for the treatment of 1,000 lb. of oil per hr., with provision for doubling the output, is seen in Fig. 1. The steam boiler and condenser for distilling the water is placed in the basement and is not shown in the plan.

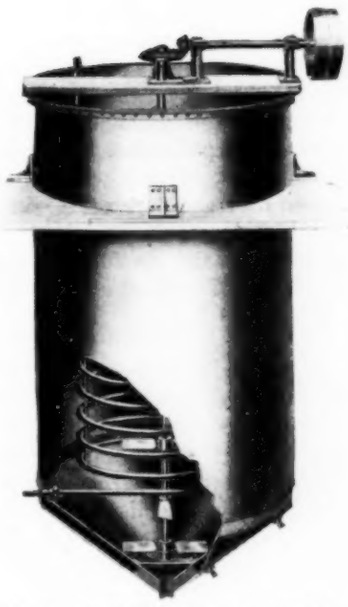

FIG. 2. PRE-TREATMENT TANK

Preparation of the Raw Oil

The characteristic of the raw oil to be treated may be thick, for instance, as cocoanut oil, therefore necessary means has to be provided for heating the oil before it is emptied into the storage tanks from the barrels and tank cars when received at the works and the oil in the storage tanks must be kept sufficiently liquid to be pumped on to the next stage.

The means provided for reducing and maintaining the oil in the liquid state consists of steam jets for heating the barrels—the tank cars usually have steam coils permanently installed with threaded connections to attach to the source of the steam supply at the works, the storage tanks have flat steam coils at the bottom. The oil in the barrels is first emptied into a vat and from this vat pumped into the storage tanks. From the tank car the oil is pumped directly into storage tanks.

Dessication of the Raw Oil

As the catalyst should not be brought into contact with moisture, it is necessary to extract the moisture from the oil by dessication. This is accomplished in the two pre-treatment tanks. First the oil is pumped from the storage tanks into the open circular pre-treatment tanks, Fig. 2, having conical bases and fitted with mechanical agitating gear and with steam-heating coils. The oil in them is freed from the moisture. The outlet for the oil is through a valve at the conical base. Steam, fluid level gages, and thermometers are fitted in connection with the pre-treatment tanks. The oil leaving the pre-treatment tanks is mixed with the catalyzer in the mixing tanks and is now ready to be brought into contact with the hydrogen in the converter.

Method of Preparing the Catalyst

There are several methods of preparation of the catalyzer, but the one to be described herein has perhaps been one of the most widely used. In general the catalyst employed is finely divided metallic nickel. It is received at the hardening plant in the form of nickel sulphate in crystals. Its preparation consists of making a solution of the nickel sulphate in tank *D* and another solution of sodium carbonate in tank *E*. Each of these tanks is fitted with an open steam jet to facilitate the preparation of the solution. They are erected over a third tank *F* provided with means for mixing the two solutions when they are turned into it. The result of this mixture is the precipitation of insoluble nickel carbonate and the passage of sodium sulphate into solution. Previous to the admission of the two solutions a quantity of finely divided refractory neutral material is placed in the mixing tank. In practice this material is usually kieselguhr. Its employment is to act as a carrier for the nickel. The mother liquor, the precipitate of nickel carbonate, and the kieselguhr are drawn off from the mixing tank and pumped through a filter press. When the filtering is completed the nickel carbonate and the kieselguhr are found consolidated on the filter cloths as cakes. These cakes are thoroughly dried in hot air driers, and then reduced to powder by means of a ball mill. The carbonate now has to be roasted or calcined in a furnace so as to reduce it to the form of oxide.

The next procedure is the very delicate operation of reducing the oxide to the metallic form. This is effected in a reduction furnace by heating at a certain temperature the oxide in contact with hydrogen, which must be entirely free from air. The furnace employed is either gas-, oil- or electrically-heated and varies in the internal mechanism. Fig. 3 is a diagrammatic sketch of one of the later improved types which is electrically heated

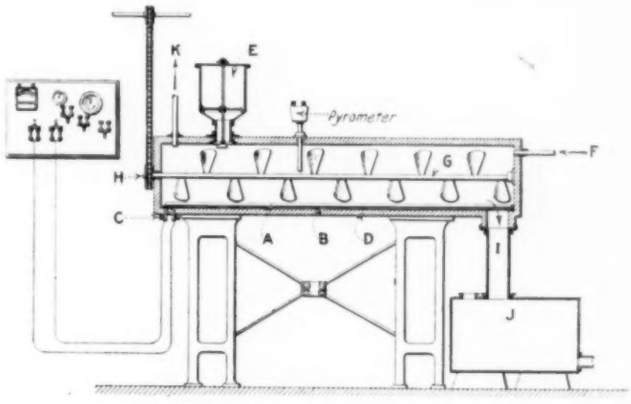

FIG. 3. DIAGRAMMATIC SKETCH OF CATALYZER FURNACE

and automatically controlled. The furnace *A* is cylindrical in form, and is closed at both ends. It is heated through the under surface at *B* by electrical connections at *C* and incased in heat-insulated material *D*. The pulverized material is fed automatically at the top *E* and the hydrogen is admitted at the end *F* and after circulating through the furnace passes through outlet *K*. Inside the cylinder there is provided a reciprocating worm *G* which is kept revolving slowly by means of the chain drive pulley *H*. The movement of the worm constantly exposes fresh portions of the material to the action of the hydrogen, and also determines the rate of flow at which the material falls through the furnace at *I*. The substance fed to the furnace in the form of the carbonate is calcined to the oxide. After leaving the furnace the reduced material mixed with the kieselguhr must not be permitted to come into contact with the air. It is therefore caused to fall into a tank of oil

J of the same kind and quality as that to be hardened. This black, oily mixture is ground to a suitable consistency, and is added, with the oil, in the converter.

In the early days the experimenter had considerable trouble with the hydrogenating process. He formed erroneous conclusions, particularly regarding the construction and mechanism of the converter. For this reason there is found a great diversity in its construction.

The secret of oil hardening depends primarily on the activity and uniformity of the catalyzer. Therefore with a highly refined oil and a catalyzer with the properties just stated the oil may be hardened in most any form of converter.

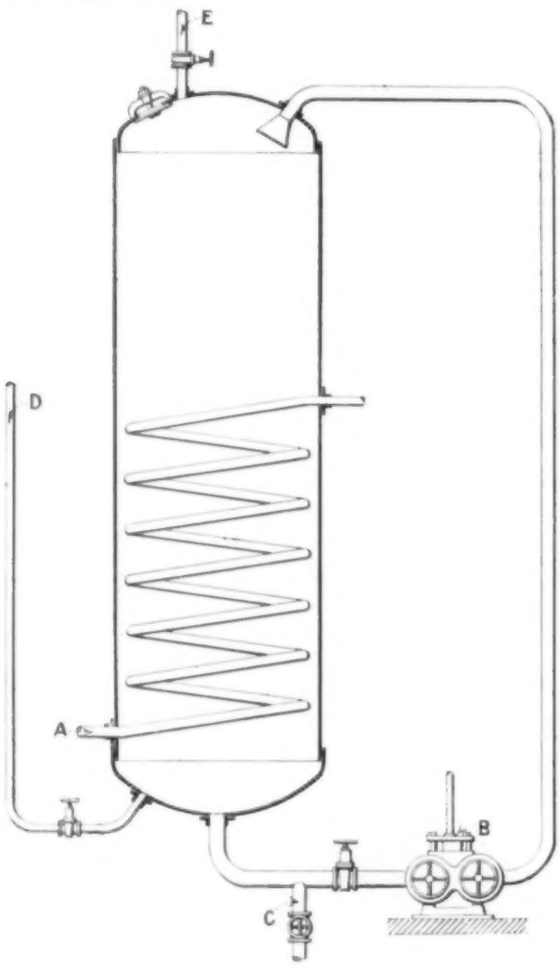

FIG. 4. DIAGRAMMATIC SKETCH OF CONVERTER

The converter as shown in Fig. 4 is a cylindrical upright tank, closed top and bottom. The lower half is occupied by steam coils; also, during operation, by the oil be be treated, mixed with the catalyzer.

A pump *B* draws the oil from the foot of the converter and discharges it continuously through a spray onto the oil in the lower half of the converter.

When conditions are properly regulated, the pressure inside the converter, as the hydrogen is pumped in, is seen to rise at first. On reaching a certain point, depending upon the temperature maintained in the oil, the pressure becomes stationary, indicating that the hydrogen is being absorbed by the oil as fast as it is pumped in. By sampling, the degree of hardness is determined, the oil is drawn from the converter through the pipe *C*, is cooled and filtered. The cooling is not sufficient to solidify the oil, but is only sufficient to prevent the oil from injuring the cloths of the filter press. Practically the whole of the metallic nickel and the kieselguhr is held back in the filters. The pressed cakes of catalyzer left on the cloth are washed and freed from oil, are broken up, and are returned to the catalyst-preparing department, where the material is ready for further use. With a well-refined oil the catalyzer may be used over and over again, for days or weeks. As there are some losses in handling the catalyzer, it is customary to make up for the loss by the addition from day to day of a small amount of fresh catalyzer.

Hydrogen Required

The amount of hydrogen required in the hardening of oils varies from 500 to 5,000 cu.ft. per ton of oil, depending upon the nature of the oil, the degree of saturation of the oil and extent of hardening required.

The amount of hydrogen consumption from actual experience on some oils is as follows:

	Cu.ft. per Lb.
Cocoanut oil	0.25 to 0.40
Soya bean, corn, peanut, cottonseed	1.75 to 2.0
Fish oils (menhaden oil)	2.0 to 2.5

The amount of hydrogen as given includes that used in making the catalyzer which would be used in the hardening of the particular oil in question.

COST OF HARDENING ONE TON OF FISH OIL (MENHADEN)

Hydrogen, 4,600 cu.ft. @ $1.15 per 1,000	$5.17½
Loss of catalyst (nickel sulphate @ $11.25 per cwt.; kieselguhr @ $4.12 per cwt.; carbonate of soda @ $13.34 per ton)	3.75
Electric current for heating @ $0.03 per kw.-hr.	.30
Power	.25
Steam, 1,375 lb. @ $0.85 per ton	.58
Water, 450 cu.ft. @ $0.20 per 1,000	.09
Filter cloths, 1 yd. @ $0.35 per yd.	.35
Labor (including preparation of catalyst):	
1 Foreman @ $0.90 per hr	
2 Laborers @ $0.40 per hr	1.70
Running repairs	.49
Total	$12.68½

The cost of hydrogen depends upon the manner obtained—for instance, hydrogen can be generated at the hardening plant, it can be purchased in cylinders and can frequently be obtained as a byproduct. In the latter event the price is very low, considerably less than in the above estimate.

It will be noted in the above estimate that this particular fish oil requires more hydrogen to harden it than vegetable oils or most any other oil excepting some certain fish, liver, and blubber oils.

The character of the generating apparatus for the production of hydrogen in relation to the hydrogenation of oils is one of utmost importance, as many factors enter into its proper selection.

The purity of hydrogen is one of importance, but there are factors that are equally as important in other ways to consider. These are:

First. Which particular type of equipment is best adapted to local operating conditions.

Second. Of the various types of the same systems of production, which types are efficient, safe, simple, most economical and conserve long life in operation.

Considerable hydrogen-generating equipment has been installed which has not proved satisfactory due to one or all of the above factors. The selection of such equipment should be left to those who are qualified by technical knowledge and long experience in the field of hydrogen-generating apparatus.

New York City.

The Lake Asphalt Industry*

Nature and Origin of Asphalt—Description of Most Important Sources of Natural Asphalt: Trinidad Lake and Bermudez Lake—Refining and Fluxing—Ultra-Microscope Shows Presence of Colloidal Clay Particles—Review of Theory of Colloidal State

BY J. STROTHER MILLER, JR.†

ASPHALT as obtained in nature and requiring very little if any refining to make it suitable for use has been of general interest for a great many years for many different purposes. In more recent years there has appeared another class of so-called asphalt produced in the oil industry when certain types of crude asphaltic oils are distilled. There being two general sources, namely, natural solid and artificial, or oil, asphalts, the question is immediately brought up, How was the natural product formed and what definition can we give of asphalt which would indicate these two general classes?

THEORY AS TO ORIGIN OF ASPHALT

Much work has been done upon that type of natural solid asphalt obtained from Trinidad Pitch Lake, in the Island of Trinidad, and I would refer you therefore to a report by Clifford Richardson upon this general subject of origin, appearing originally in the *Journal* of the Society of Chemical Industry for January, 1898. Briefly summarized, the theory there outlined is that asphalt is in the process of formation today. It does not originate as such, but is a secondary product, resulting from the transformation of suitable lighter form of bitumen, malthas, or even thinner oils, into harder bitumen by condensation and polymerization, a reaction in which sulphur and probably sulphates seem to take an important part. No high temperatures seem necessary once the change is initiated, but time is necessary.

MANUFACTURE OF OIL ASPHALT

The method of manufacturing an oil asphalt is probably familiar to you all. As asphaltic oil is distilled, the gasoline naphthas, burning oils, gas oils and lubricating oils are obtained from the distillate, and the residue is controlled to give the best grade of oil asphalt obtainable from the particular crude oil under manipulation without economically sacrificing any of the more valuable distillates.

ASPHALT DEFINED

There have been several definitions proposed for asphalt. I will cite two or three.

First. Asphalt may be simply defined as a solid or semi-solid form of mineral bitumen, either pure or containing more or less mineral or other earthy matter. Speaking in general terms, it may be said there are three grand divisions of natural mineral bitumens, viz., gaseous, liquid and solid. The asphalts consist of a mixture of various saturated and unsaturated solid hydrocarbons and their derivatives.

Second. Asphalt, solid or semi-solid native bitumens, consisting of a mixture of hydrocarbons of complex structure, largely cyclic and bridge compounds, together with a small proportion of their sulphur and nitrogen derivatives, but free from any appreciable amount of solid paraffines, melting upon the application of heat and evidently produced by nature from petroleums containing little or no solid paraffine. Solid or semi-solid residues produced from probably similar oils by artificial processes are sometimes called asphalts, but should properly be termed oil asphalts. The more common types of native asphalts are known by the name of the locality in which they occur, such as Trinidad, Bermudez, Maracaibo, Cuban, California, etc. Native asphalts with few exceptions contain water, extraneous organic or vegetable matter and inorganic matter such as clay, sand, etc.[1]

Third. Solid or semi-solid native bitumens. Solid or semi-solid bitumens obtained by refining petroleums, or solid or semi-solid bitumens which are combinations of the bitumens mentioned with petroleum or derivatives thereof, which melt on the application of heat, and which consist of a mixture of hydrocarbons and their derivatives of complex structure, largely cyclic and bridge compounds.[2]

I could go on indefinitely through the literature and show that most every author has given his own definition. This chaotic condition is receiving serious attention by several different societies at present.

SOURCES OF NATURAL ASPHALT

With this brief and general outline let us proceed to the description of the two sources of native asphalt from which the largest amount of ashphalt has been pro-

*Presented at the Dec. 8, 1919, meeting of the New Jersey Chemical Society, Newark, N. J.

†Chief chemist, Technical Department, Barber Asphalt Paving Co., Maurer, N. J.

[1]Office of Public Roads, Department of Agriculture, Circular 93.

[2]Progress report of Special Committee on Materials for Road Construction presented at the annual meeting of the American Society of Civil Engineers, Jan. 20, 1915.

FIG. 1. RELATIVE LOCATIONS OF TRINIDAD AND BERMUDEZ ASPHALT LAKES

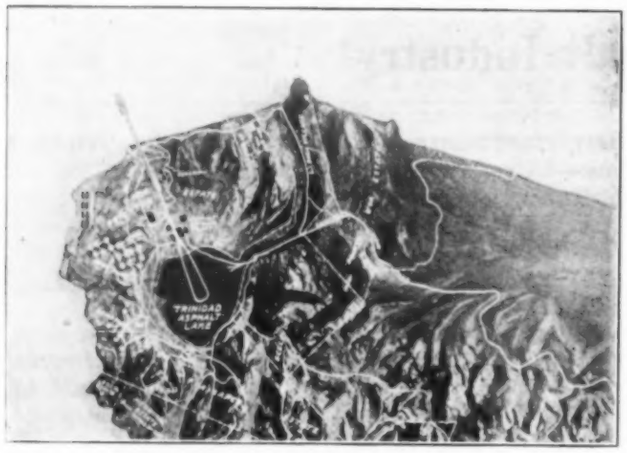

FIG. 2. RELIEF MAP SHOWING LOCATION OF TRINIDAD ASPHALT LAKE

duced, namely, Trinidad and Bermudez Lakes. The two lakes are situated in South America; the Trinidad Lake on the western coast of the Island of Trinidad in the British West Indies, and the Bermudez Lake on the eastern coast of Venezuela about thirty miles inland by air line. The relative locations of the two lakes are shown in Fig. 1. The Gulf of Paria, about eighty-five miles in width, separates the Island of Trinidad from Venezuela.

The island is about 700 miles north of the Equator and about 2,000 miles south of New York City. Its area is about 1,700 square miles, or less than the area of the State of Delaware. The climate is tropical, but is favored by the trade winds which tend to ameliorate the tropical temperature, averaging as it does about 85 deg. F. the year round, never varying more than 20 degrees. The only difference between one season of the year and another is the difference in rainfall.

Description of Trinidad Lake

The Trinidad Lake, and "lake" best describes it, is situated about one mile from the sea and about 138 ft. above sea level. Fig. 2 is a relief map showing the exact location of the lake. It is about 114 acres in extent. Its surface is undulating, the mass of asphalt seemingly lying in large folds, and where these folds meet there is a crevice formed, varying in depth from a few inches to a few feet in which rain water constantly stands, forming miniature canals. This characteristic formation is illustrated in Fig. 3. The mass is in imperceptible constant motion, which can be detected only by noting the relative position of the miniature canals at various times. This motion is also indicated by its behavior after digging, as will be described later on. Fig. 4 shows one edge of the lake.

Depth of the Lake Unknown

The greatest depth of the lake has never been found. In 1893 a series of borings were made, and the one at the center of the lake was carried to a depth of 135 ft., the entire depth being through solid asphalt of uniform character and composition, but the boring had to be abandoned, as the tube or casing had been carried so far from the vertical (one foot in six) as to render any further boring valueless. The depth found, however, indicates an almost inexhaustible supply of this wonderfully uniform material, for while mining has been carried on continuously for over thirty-eight years, the level of the lake has dropped only 6 or 8 ft. in all that time. This would seem apparent, for there is a perceptible rise in the center of the lake, but the new material is either of the same character or replenishment must be very deep, else the borings would have indicated a change in character. The borings near the edge of the lake indicated considerable slope to the sides, and it is believed the lake rests in a bowl-like depression, probably an extinct mud volcano.

Digging and Transporting Crude Trinidad Asphalt

There is a narrow-gage road and endless cableway running from the refinery out over the lake, and turning in a large semi-circle so as to traverse as much of the lake as possible, returning to the starting point. This road is not ballasted, yet there is very little sinking of the ties into the asphalt. A train consisting of several small flat cars, each car carrying a dumping bucket of about 500 lb. capacity, is pulled over this track by an endless cable running over the ties, and by means of a portable clutch a native sitting on the front of a train is able to start or stop the train at will. The natives dig the solid asphalt with broad mattocks and load the chunks into the cars by hand. The space left after a day's digging is completely filled within forty-eight hours, which is another proof of the continual motion of the mass of asphalt. After loading, the cars are pulled either to the refinery or the terminus of an endless overhead cableway which carries the loaded buckets down hill and out over the dock to the steamer, the loaded buckets going down hill, producing sufficient power to pull the empty buckets up hill. The crude Trinidad asphalt, as it is called, is shipped in bulk in the holds of steamers, to all parts of the world, but during transit amalgamates into a solid mass and has to be dug out again.

Description of Bermudez Lake

We will now journey for a moment into the wilds of Venezuela to take a hasty glance at the Bermudez Lake. The only means of approach from the Gulf of Paria is by steamers up a desolate river known as the San Juan. For five hours we see nothing but mangrove swamps on either side of this wide and placid river, the only signs of life being the customs officials' hut at its mouth, and myriads of multi-colored birds. The last five miles of the trip is up a tributary of the San Juan known as the Guanoco River. This really is a deep creek, it being so narrow that the steamers cannot turn, so they turn at the fork of the two rivers and

FIG. 3. WATER STANDING IN FOLDS ON SURFACE OF TRINIDAD LAKE

back up to the dock at Guanoco in order to have a straightaway course when loaded. We take a narrow-gage road at Guanoco for a seven-mile trip through jungleland. Indeed, you cannot step off the ties of the road without going up to your ankles in water. All through this jungle you see the beautiful tropical flowers and birds of many colors, but never a note of song from the birds or a sweet scent from the flowers.

Bermudez Lake (Fig. 5) is about 2,000 acres in extent and varies from 3 to 10 ft. deep in those parts that have been worked. It is not quite as hard as the Trinidad Lake and the ties supporting the railroad have to be shifted frequently. There is considerably more water to contend with here, as the seasons vary by one

FIG. 4. EDGE OF TRINIDAD ASPHALT LAKE

being wet and the other very wet. There is also considerably muddy silt to be mucked off the top, this mud being washed in by the heavy rains from the hills to the west. Owing to this mud you will find more vegetation on this lake than on the Trinidad Lake.

Handling Crude Bermudez Asphalt

The asphalt is loaded by hand into dump cars which are pushed by natives in trains of three or four cars to an elevated track at the edge of the lake, there to be dumped into wooden skips. These skips are hauled on flat cars seven miles to the steamer's side at Guanoco, lifted by the steamer's winches and dumped into the vessel's hold. The Bermudez crude runs together while in transit, the same as the Trinidad, and has to be dug out again upon its arrival at destination.

Refining Crude Asphalt

As the operation of refining is the same for both asphalts, we will describe more fully the Trinidad.

As obtained crude, the Trinidad contains approximately and uniformly through all cargoes, 39 per cent of bitumen, or that portion that is soluble in carbon disulphide, the accepted solvent of the asphalt industry for determining bitumen, 32 per cent of mineral and other matter, and 29 per cent of water. For comparison, Bermudez crude varies as to its water content, averaging about 25 per cent, 1 to 3 per cent of mineral matter and 68 to 72 per cent of bitumen. The refining in either case consists in driving off the water in a steam-heated still open at the top, at a temperature of about 350 deg. F. It takes about eight hours to refine a still of fifty to seventy tons. It is then either drawn off into slack barrels, such as cement is shipped in, surface cooled by water to prevent splashing while being hauled about the refinery yard and shipped direct to customers or is fluxed before drawing.

Fluxing Refined Asphalt

Fluxing of a refined asphalt consists in adding a predetermined quantity of a petroleum residuum, or flux, which flux is bought under stringent specifications assuring a uniform material suitable for paving and other purposes. Refined asphalts have a consistency or penetration of from about 2 deg. for Trinidad to 20 deg. for Bermudez. This consistency is determined by means of a sewing needle of certain size and make, under a fixed load acting for a fixed time at a standard temperature and a degree of penetration is ten times the number of millimeters the needle sinks into the asphalt. The refined is too hard for use in paving operations. The proper consistency is dependent upon climatic and traffic conditions, as well as the grading of the mineral aggregate with which it is mixed to produce a paving mixture. The fluxed asphalt must not be too hard in cold weather and yet not too soft in summer. You have all noticed and I presume heard unfavorable comments upon the softness of some sheet asphalt pavements in the summer time. Did you ever see a sheet asphalt pavement with heel marks, horses' calk marks or tire tracks in it in winter? What becomes of them? They iron out, and a pavement that does not mark a reasonable amount in summer must be viewed with suspicion. It will probably be too hard in winter. This is one feature in which technical control has been and will be of much assistance to the paving industry.

Asphalt Cement

When the refined is fluxed it is called an asphalt cement, as it is used to cement particles of mineral matter together, and after a still has been fluxed to proper penetration or consistency it is shipped in either single or double head hardwood barrels, according to

FIG. 5. VIEW OF BERMUDEZ ASPHALT LAKE

its consistency, and is ready for use when received, except that it has to be remelted. Some customers prefer to flux the refined themselves; others desire it ready fluxed, and for country road purposes it is shipped ready fluxed in the majority of cases.

Asphalts have been applied to many different uses in the past few years and the simple fluxing to varying degrees of consistencies referred to above does not ade-

FIG. 6. LOADING DOCK AND STEAMER IN GUANOCO RIVER

quately describe conditions today. Some uses require the softest, while another use requires the same melting point but a much harder consistency. Such variations are obtained by proper blending of two or more asphalts or the incorporation of materials other than asphalts. Obviously the type of material suitable for use in hard rubber compounds would not be suitable for saturating canvas to produce a waterproof and mildew-proof piece of goods. Neither of these products would be applicable for building tank linings to withstand temperatures up to 120 deg. F. and mixed acids (such as sulphuric and nitric of about 25 per cent strength) such as are met in the dye industry.

Colloidal Mineral Matter in Trinidad Asphalt

I would like to refer now to the mineral matter that occurs in Trinidad Lake asphalt. It appears to exist in a colloidal state, so we will consider that subject very briefly, for while many of you are, no doubt, familiar with this subject, yet those present who have not ventured into this realm of the "poetry of chemistry," as it has been aptly termed, will no doubt find something of interest to their own problems or difficulties, for colloidal conditions exist all around us; in fact, Dr. Fisher would have us believe the human system is more or less a colloidal one, the tissue structure being a water-in-oil emulsion, which is another way of describing a water colloidal dispersion in oil.

Graham's Investigation of Colloids

The first systematic investigation of and the name "colloids" are due to Thomas Graham, whose results were published in numerous papers between 1861 and 1864. His discoveries may be briefly summarized under two general heads. In studying dialysis of various substances, i.e., the diffusion of dissolved substances through organic membranes like parchment into the pure solvent, he found that some of them passed freely through the membrane into the surrounding solvent, while a number of others failed to do so, or diffused at an extremely slow rate. Generally speaking, the former were bodies which were known to crystallize, while the latter, like glue, gelatine, gum arabic, etc., were known only in the amorphous condition. Graham accordingly divided soluble bodies into two classes, crystalloids and colloids (from colla, meaning glue).

The second discovery was that a number of substances generally considered as insoluble could, by appropriate methods, be obtained in what at first sight appeared to be real solutions. They did not, however, diffuse through parchment, and on account of this property they were called "colloidal solutions" or simply "sols," which term has now become generally accepted. These "sols" showed a further striking peculiarity, which distinguishes them sharply from true solutions, as extremely small additions of electrolytes or reagents such as ordinarily would not react at all with the dissolved substances caused radical alterations in the condition of the solutions. Silicic acid sol sets to a transparent jelly when a trace of carbon dioxide is added thereto, and a ferric hydroxide sol is immediately broken down by a slight addition of sodium sulphate with the precipitation of the ferric hydroxide as a flocculent mass. Obviously these were phenomena quite different from known reactions of a purely chemical nature and the sols had to be considered as systems differing from ordinary true solutions.

Ultra-Microscope Aids Study of Colloids

Since Graham's time the whole subject has been studied by an ever-increasing number of investigators, both physicists and chemists, with new methods and appliances, the most important of which has been the ultra-microscope, invented in 1905 by Zsigmondy and Siedentopf, which even in that short time has enormously enlarged our knowledge of colloidal solutions. The principal step forward in theory has been the proof, now quite conclusive, that "colloids" in Graham's sense are not a definite class of substances, but that by suit-

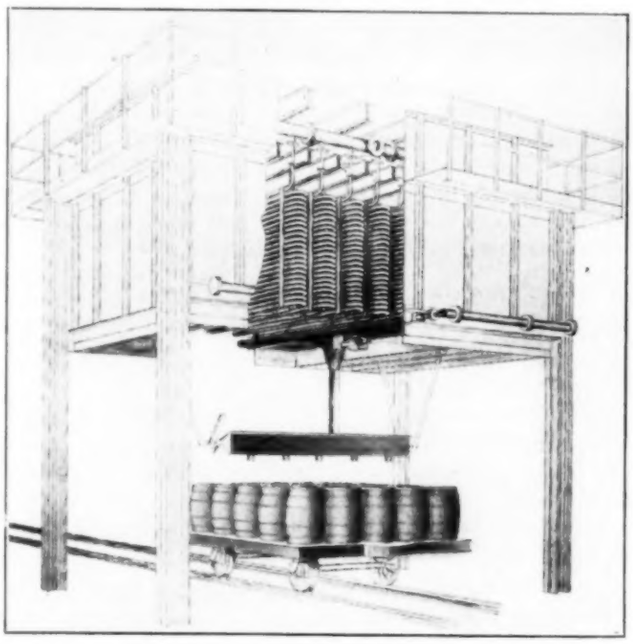

FIG. 7. STEAM STILL FOR REFINING ASPHALT

able means and methods a very large number of bodies can be prepared in a colloidal condition, which indicates and is generally accepted that it is a *state* and not a *form* of matter.

Bancroft's Views on Colloidal State

More recently, W. D. Bancroft has stated that Graham's view that a colloidal substance must be amorphous has been dropped and we now call a phase or state of matter colloidal when it is sufficiently subdivided, not committing ourselves definitely as to the degree of subdivision. Colloidal chemistry appears to Bancroft as the chemistry of bubbles, drops, grains, films and filaments.

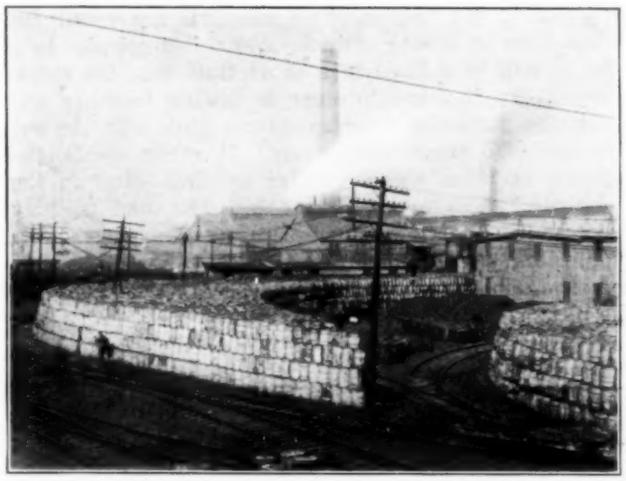

FIG. 8. STORAGE PILE OF REFINED LAKE ASPHALT IN SLACK BARRELS

All surfaces, both of solids or liquids, have the power of adsorbing solids, liquids, or gases. A familiar instance of this is the formation of an air film or water film on the surface of glass. It is perfectly familiar to all of us that small drops of a liquid will coalesce to a single drop when brought in contact. It is not so familiar that solids also coalesce when brought in contact, because solids, as we know them, have a film of air on the surface and we do not actually bring them in contact. Cushman and Goggeshal report in their work that a powder which would pass a 200-mesh screen surged like a liquid. The film of air was so large relatively to the mass of the particles that they were really dealing with little elastic balls having a hard core. Heating drives out the air film and tends to make solids more malleable so that pressure brings more points into actual contact. We can join two pieces of glass while they are still very viscous, and we join two pieces of platinum in the laboratory at temperatures far below its melting point. Cleaning of surfaces prior to soldering is another familiar instance, although here we have the question of clean surfaces as well as absence of air film.

In the above discussion Bancroft is attempting to develop the thought that solid grains or liquid drops will agglomerate if actually brought into contact, and to keep them from doing so we must have a surface film of some sort. Dirty mercury will remain as a single liquid mass indefinitely. If we disintegrate the mass, a film will form over each drop and will prevent the drops from coalescing. The case of breaking this mass of mercury depends upon the surface tension of the mercury.

Brownian Movement of Fine Particles

If we drop a stone into water, it sinks rapidly; if we grind the stone into coarse particles, these sink less rapidly; if we continue to grind finer and finer, we finally reach a point or state that we would expect the particles to sink the slowest, the rate, of course, being a function of their diameter. This is not the case, however. When the particles are subdivided below a certain size, they actually fail to settle out. They then take on a constant unceasing motion known as the "Brownian movement." This movement was first noted in 1827 by Dr. Brown, a botanist, after whom it is named. The movement is composed of an oscillating motion of particles around a central position and an erratic translatory motion.

This motion decreases as particles grow larger and ceases entirely if the diameter exceeds a certain size. Various suggested causes, such as vibration, convection currents due to changes of temperature or of concentration were gradually eliminated by experiment, and it became evident that the movement could hardly be due to any transient cause.

The study of the phenomena received an enormous impetus by the invention of the ultra-microscope, as the very small particles disclosed by it for the first time showed it so vividly that Zsigmondy was inclined to look on it as something differing not only in degree but also in kind from the Brownian movement. Methods were devised which facilitated the measurement of the amplitude of oscillation—that is, the time between two similar positions.

Theory as to Cause of Brownian Movement

Since then various mathematical relations between these quantities have been developed, but the theory as to the actual cause of this Brownian movement is still in dispute, although the most generally accepted theory seems to be that the whole phenomenon conforms to conclusions drawn from the kinetic theory and that there is no essential difference between this motion and molecular motion. The stability seems also to be intimately connected with the electric charge, as it has been shown generally that colloidal particles are so charged.

Ultra-Microscopic Study of Mineral Matter in Asphalt

For many years the insistent presence of a small percentage of mineral matter in all extracted bitumen from Trinidad Lake asphalt baffled the operators, and while we all felt it was a very finely divided clay, yet it was not until 1914 that Clifford Richardson initiated the work that finally showed us these particles in the ultra-microscope.

Richardson's Theory of Asphalt Formation

How this clay occurred in this manner is explained by Mr. Richardson briefly as follows:

"The crude asphalt in the lake consists of a complex system of several phases, gaseous, liquid and solid, organic and inorganic, more or less in equilibrium, displaying colloidal properties of industrial as well as scientific interest. The asphalt owes its origin to certain geological conditions existing side by side in that locality. Oil sands occur at different depths, which contain vast quantities of petroleum, as has been demonstrated by the many wells which have been successfully sunk, a petroleum of unique character, differing from any previously known, and of a highly asphaltic nature. Rising toward the surface along some line of least resistance, the petroleum meets the paste of fine silica and clay which forms the mud of the spring. With this the oil becomes emulsified, probably by the action of the natural gas which accompanies it at very high pressure. In the lapse of time the entire crater of the spring has been filled with the resulting material and it has overflowed the rim, running down the slopes to the sea.

"Fresh material is in process of formation today and issues at several points on the surface of the deposit of a consistency so soft that it can be readily molded into balls with the hands, without adhering to them owing to the free water with which it is associated. This

so-called "soft pitch" is also accompanied with natural gas of unusual composition, containing, in addition to the hydrocarbons usually found in such gas, carbon dioxide and hydrogen sulphide, in some localities in the neighborhood of the deposit as much as 33 per cent of the former and 3.5 per cent of the latter. At the same time the soft pitch itself is evolving gas, either the result of the release of pressure or of a reaction going on between the bitumen and the mineral matter it contains, this gas consisting largely of hydrogen sulphide and carbon dioxide, probably the latter cause, as it continues for years after the material has been exposed to the air, while if the soft asphalt is sealed up in a tin can the latter will explode in the course of time from the gas pressure developed.

"The main mass or older form of the asphalt in the crater is sufficiently hard to make it possible to flake it out in large pieces of from 50 to 100 lb. in weight. In this form it resembles an exaggerated Swiss cheese owing to the gas cavities it contains. While brittle enough for this, an excavation of some depth at any point is filled up and obliterated in twenty-four hours by the flow of asphalt from the adjoining material. Large masses of the asphalt taken from the deposit and kept in storage, without lateral support, present all the features of the glacial flow of ice.

"The asphalt, therefore, originating in a soft condition as demonstrated by the fresh material, which is constantly being formed and which emerges near the center of the deposit, becomes hard in the course of a year or two. The cause of this and of the evolution of the gas which is observed may be attributed to the presence of a catalyzer. As will be shown, the asphalt contains clay in highly dispersed condition, carrying adsorbed ferrous sulphate, which may play such a role."

Colloidal Suspensions of Clay in Pure Bitumen

In the endeavor to reproduce these conditions, clays from many different sources, including clays from oil springs found on the Island of Trinidad, have been experimented with in many ways and that method showing the most promise is to make a clay slurry with water, adding this to a pure bitumen at a temperature below that of boiling water and slowly cooking out the water. This method results in some colloidal particles in the bitumen, but not nearly approaching the number per unit of volume as found in the lake asphalt.

Examination of Bitumens by Ultra-Microscope

In preparing a bitumen for examination by the ultramicroscope, it is best to have about a 10 per cent solution of bitumen in benzol. After swinging for one-half hour or more in a centrifugal machine it can be examined immediately, or if it is desired the solution can be allowed to stand for several months or filtered through a Chamberland filter. Whether one or all of these methods are followed, we still find the particles persisting in the solution.

Effect of Colloidal Clay on Physical Properties

These minute particles of clay no doubt adsorb the bitumen, creating a surface energy far in excess of any type of mineral filler added to a bitumen in the usual dry way such as in making a sheet asphalt mixture. If we add to one portion of a bitumen a percentage of dry clay and to another portion of the same bitumen add the same quantity of the same clay, but in the form of a slurry, and the resulting mixtures are rolled out in the form of a long cylinder and coiled spirally in a tube, it will be noticed in a short time that the spiral made of dry clay and bitumen is flowing together and deforming generally, whereas the one made with the wet clay holds its shape indefinitely. In other words, the colloidal clay has had a greater physical effect in the mechanical modification of the bitumen than the dry clay. It has made a more stable bitumen as regards its susceptibility to temperature changes without any chemical modification of the hydrocarbons composing the bitumen.

This experiment conclusively shows the effect of increased adsorption due to the colloidal state of the mineral matter in Trinidad Lake asphalt. This adsorption increases the surface tension or energy of the film, thus increasing the stability.

Awakened Industrial China

In speaking before the Chicago Foreign Trade Club recently, Julian Arnold, commercial attaché of the U. S. Department of Commerce, reviewed the developments which have been made in the Orient in the past twenty years, with especial reference to China. There has been during that time a modern educational system installed, the growing of opium has been wiped out, a modern press is being developed, with over 300 newspapers published regularly, and a national spirit has been awakened.

In the line of foreign trade possibilities there is a population of 400,000,000 people as compared with 70,000,000 in South America. There is as much coal in China as in the United States. They also have iron ore, antimony, zinc, lead and tin, and these resources are now being opened up. Eighty-five per cent of the population is engaged in agriculture, with the farms averaging five acres each. The great outstanding problem is the lack of transportation. Give China 100,000 miles of railroads and these markets will be opened to the entire world, developing this section of the earth to ideas of modern industrialism.

The Shanghai Chamber of Commerce is doing much to help the American manufacturer in finding markets in the Orient. American goods are popular because of the quality marketed. The language must be taught in our universities. The cable service should be improved. As conditions are today this country offers the greatest trade opportunities in the world.

Extension of Laboratory Facilities for Analysis of Imports in Brazil

A law of Jan. 13, 1920, provides for the immediate establishment of laboratories for the analysis of imported products in the custom houses of Santos, Porto Alegre, Corumba, Recife, Bahia, Parahyba, Fortaleza, Maranhao, Belem, and Manaos, with the gradual extension of such facilities to all the custom houses of the republic for the purpose of preventing the introduction of articles injurious to the public health. A fee of 2 per cent of the total import duties, payable in paper currency, is to be charged for the analysis of the following articles: All kinds of fabrics; chemical products, drugs, and pharmaceutical preparations; canned meats and fish, excepting codfish; vegetables; starches; cheese; butter; all other alimentary products; and articles used in the preparation of foods and drinks.

General Sibert and the Chemical Warfare Service

BY PAUL WOOTON

NO SURPRISE was occasioned among his close friends when Major General William L. Sibert requested that he be relieved of the command of the Fifth Division at Camp Gordon, Ga., and be placed on the retired list of the Army. While no complaint or comment is coming from General Sibert, it is well known in Washington that his heart was in the Chemical Warfare Service and despite determined efforts to take up army post life again, he found it impossible to do full justice to his assignment. General Sibert expects to embark in the near future in active private work.

While General Sibert is not a chemist, he is recognized as having been the most important single factor in the development of the Chemical Warfare Service. He regarded the upbuilding of this branch of the Army as the crowning achievement of his military career. He is understood to be very grateful for having been permitted to continue his work to the point where he persuaded the Congressional committees in charge of military legislation that the development of chemical warfare should be pursued actively and entirely independently of the other subdivisions of the War Department.

GENERAL WILLIAM L. SIBERT
Former Director of the Chemical Warfare Service, Who Has Applied for Retirement from the Army

In view of the personal feeling that it was necessary to arouse in thus opposing the wishes of the General Staff, it is believed that General Sibert realizes that the work now can be carried on best by another, and is more than satisfied with the assurance that chemical warfare is not to be a subdivision of an existing War Department agency and that active development of this branch of the military service is to be continued. The wisdom of such conclusion is evidenced by the growing interest within the War Department in the Chemical Warfare Service, and it is believed now that all concerned will co-operate to secure the maximum benefits from the work which will be carried on by that arm.

In the view of his associates, General Sibert's greatest achievement came during the war in bringing the agencies engaged in chemical warfare activities into a cohesive whole. When he was assigned to the gas warfare section, as it was known then, General Sibert found the manufacture of masks being conducted under one agency, the manufacture of gas and the filling of shells under another, while the training of gas troops was under still other direction and a fourth agency was in charge of gas research.

Good work was being done in each particular line, but the greatest difficulty was being found to secure the desired co-ordination of all the activities entering into gas warfare. This unification of the chemical warfare activities was made just in the nick of time. Operations at the front were being hampered by the lack of certain materials not properly supplied by some of the former subdivisions. The situation became so bad that a cable was actually sent from headquarters in France to General Sibert, advising him that it would be necessary to stop the offensive use of gas troops unless these materials could be made available in the very near future. With his then unified service, General Sibert found no difficulty in bringing about the quantity of production required.

General Sibert's experience in the field was particularly valuable to him in making up the work in this country to meet practical conditions existing on the front. Through the lack of intimate touch with field conditions, the manufacture of vincennite continued on a considerable scale in this country some time after its worthlessness under battle conditions had been demonstrated to the satisfaction of the chemical officers with the expeditionary forces. Vincennite, which promised so much under laboratory and experimental conditions, failed to give results in actual battle because anything less than killing quantities of the gas in no way impaired the effectiveness of the enemy. It was in such matters as these that General Sibert proved of such help to the situation just at the time when it was most critical.

The fact that General Sibert knew only the chemistry of the West Point graduate and of the engineer led him to lean heavily on the prominent chemists with whom he surrounded himself. He had no preconceived theories of his own, which might have been the case had a chemist been thrust into a work concerning which there were so many uncertainties. His lack of technical chemical knowledge led him to concentrate on the practical phases of the service, an aspect now held to have been equally responsible with the remarkable technical achievements for the success of the American Chemical Warfare Service in the World War.

Current Events
in the Chemical and Metallurgical Industries

New Jersey Chemical Society Holds Annual Meeting

The New Jersey Chemical Society is one of the progressive organizations of that state. The steady, remarkable growth which it is enjoying was evidenced in more ways than one at the annual meeting, held at Achtel-Stetter's, Broad St., Newark, on Monday evening, April 12, for despite the handicaps brought about by the railroad strike, there was a good attendance and an excellent program, with good-fellowship prevailing in overflowing measure. The reports presented showed conclusively that the association has become an important factor in this industry in the state, and its work is receiving more and more attention.

The organization is in a way still in its infancy. It was organized in 1918 with primary purpose to bring into closer contact those in the trade, profession and business, and at the same time permit those interested in chemical work to participate in its proceedings. Many monthly meetings have been held and a real, concrete interest has been secured for the benefit of all concerned. To Carleton Ellis, of Montclair, N. J., a large measure of credit is due, for as president of the association since its inception, and greatly instrumental in its formation, he has piloted affairs in an able, masterful way, giving considerable time and attention to the work, with no little effort devoted to increasing the membership.

Election of Officers

Mr. Ellis was re-elected president at the annual election, thus filling the chair for the third consecutive time. R. P. Calvert, who has been acting secretary of the association, was elected vice-president, succeeding Frederic Dannerth, who has recently taken up residence in Brooklyn. D. K. Howard was re-elected treasurer, while J. A. Wilson was appointed secretary. Those comprising the board of governors for the ensuing year will include H. G. Cawley and G. A. Armstrong. Others acting on this board during the year past are H. B. Baldwin, R. P. Calvert, W. A. Lucas, C. P. Titus, F. D. Crane and E. G. Little.

The first year book of the association has been published, and is a comprehensive and valuable volume. It reviews the association's activities up to a recent date and sets forth a list of the chemical and affiliated industries now operating in New Jersey. Incidentally, this list makes a fine showing, for the broadening of the industry in this section during late years is generally well known.

The program for the evening was preceded by the usual fine dinner, which was thoroughly enjoyed by those assembled. The principal addresses were made by Linn Bradley, of East Orange, and J. V. Meigs; the first dealt with the development of the potash industry in the United States, while the latter covered the subject of alcohol and other motor fuels as substitutes for gasoline.

Mr. Bradley, as chief engineer for the Research Corporation, of New York, has had a broad experience in the potash branch of the industry and speaks with authoritative and definite knowledge of this subject. He has given particular attention to the matter of potash recovery and devoted a large part of his paper to this phase of work.

He spoke of the installation of potash recovery plants at various cement mills, the first successful plant of this nature being that of the Riverside Portland Cement Co., at Crestmore, Cal., a development which came about after the installation of the Cottrell processes at this works for dust elimination.

Reference was made to the recovery of potash as a byproduct of blast-furnace operation, showing extensive accomplishments in this direction. The initial work of this character developed as a result of investigations at the plant of the Bethlehem Steel Co., at South Bethlehem, Pa. With the potash balances made, iron ores have been found in various parts of the country that give as much as from 1 to 3 per cent of potash, notably in the Alabama district, and yet carry sufficient iron for profitable blast-furnace operation.

A particularly interesting mention covered the forthcoming activities of a large potash corporation now building a plant in New Jersey for the production of potash from what is termed "New Jersey green sands." This plant, located in the Raritan River section, will be one of the largest works of its kind in this part of the country; it will be devoted to a varied, yet affiliated line of manufacture, including lime, potash salts, potash brick, green sand residue and other products. The company has acquired extensive green sand properties, containing a percentage of potash, near Eatontown, Monmouth County, and will use this as the source of supply. The process covers the heating of this so-called green sand mineral with lime for the extraction of potash.

Gasoline Substitutes

Mr. Meigs in an interesting talk outlined the necessity for the development of practical substitutes for gasoline, particularly in the line of fuel for automobile motors. He said that figures made public by oil experts indicated that native supplies of crude oil would be exhausted at a not very remote date. At the present time alcohol, he pointed out, gave evidence of being the most promising substitute, with shale oil closely allied in this connection. Various methods of obtaining alcohol were also considered by Mr. Meigs, dealing with standard practice of today.

Imports of Scientific Apparatus

Imports of scientific apparatus during February of 1920 were valued at $2,555. This compares with imports during the corresponding month of 1919 of $2,092. Imports of scientific apparatus during the eight months ended with February were valued at $48,191, which shows a decrease from the imports during the corresponding period of the year previous, when they totaled $69,113.

Further Nitrate Hearings

The hearings before the Senate Committee on Agriculture regarding the proposed fixed nitrogen corporation were continued daily from Thursday, April 8, until the following Tuesday. Supplementing the general criticisms (reported last week in CHEMICAL & METALLURGICAL ENGINEERING), Mr. Washburn, president of the American Cyanamid Co., again emphasized that there is no place in the present market for the material which the administration expects to make at Muscle Shoals.

E. Kilburn Scott called the attention of the committee, in Mr. Washburn's presence, to certain contradictions which he alleges will be found in Mr. Washburn's present statements and those which he made in 1916, when he urged the erection of the Muscle Shoals plant. Mr. Scott says that Mr. Washburn is now condemning his own plan.

LANDIS SUMMARIZES OBJECTIONS

W. S. Landis, chief technologist of the company, also was on the stand, taking up particularly other testimony which was presented to the committee and criticising various alternate proposals to the production of certain chemical products at these plants, particularly the possibility of making calcium nitrate, ammonium nitrate and ammonium nitrite.

In résumé of the objections of the company to continuance of Muscle Shoals operations, he stated three reasons, as follows: (1) The corporations cannot easily compete with the Government, which charges no amounts to operation for taxes, etc. (2) Operation by the Government will unreasonably take away from existing companies their patronage in fields which they have developed at considerable expense to themselves. (3) Continuance of the plant operation on the basis proposed will amount to an appropriation by the Government of processes and patents which belong to private interests and are beyond the contract rights of the Government.

Special emphasis was laid upon the point that completion of the dam operation at the present high prices of materials was considered commercially wrong. Costs of materials used in the Government estimates for the plant operation were also criticised; particularly the charge for coke at $6 per ton, was characterized as too low and the charge of 5c. a lb. for electrodes was criticised. However, explaining these charges, Colonel Burns of the War Department stated that the best estimates as to stable future conditions were taken in these points and the correspondingly low income from the sale of the products had been assumed. Therefore it was his belief that these low prices for materials were amply offset by the fact that $65 per ton was the amount estimated as the Government income from the sale of the ammonium sulphate, whereas present market conditions are very much above this figure.

SCOTT SUGGESTS USE OF ARC PROCESS

E. Kilburn Scott of New York City also appeared before the committee favoring the bill for the continuance of the plant operation by urging that the arc process should be used in part in the course of development. An extensive presentation of the claimed merits of this process and the advantages believed to accompany its use at Muscle Shoals under present conditions were set forth.

The War Department requested opportunity to reply to the criticisms and the hearings were adjourned to be resumed on Tuesday morning, April 20, at which time the nitrate division was to resume its arguments.

GRAHAM COMMITTEE TO REPORT SOON

Within two weeks Representative Graham of Illinois, chairman of the committee investigating expenditures in the War Department, expects to address the House giving the conclusions of the majority of the committee as to the activities of the Government looking to the manufacture of nitrogen.

War Department Releases Sodium Nitrate

During the discussion in the House of Representatives of the resolution authorizing the Secretary of War to turn over a portion of the reserve of nitrate of soda it was revealed that the Government's reserve was purchased at a cost ranging from $56 to $84 a ton. It was declared on the floor of the House that there would be no loss to the Government in the transaction, as the price which would be received would be in excess of the original cost of the nitrate.

The resolution as drafted and approved by the Secretary of War called for the use of 50,000 tons of the War Department's reserve. The House approved the amendment, however, increasing the amount to 100,000 tons. It also amended the resolution previously passed by the Senate so as to allow the outright sale of the nitrate rather than require replacement with a similar quantity of nitrate.

In an effort to make profiteering in this material more difficult two additional amendments were adopted. One provided that "not less than one ton or more than 100 tons may by sold to any purchaser." The other amendment requires the Secretary of War to report to Congress not later than Dec. 6 the names of all the purchasers together with the prices realized from each sale.

Zinc Tariff Bill Reported Favorably

After a long delay the Senate Committee on Finance has reported favorably, without amendment, the zinc tariff bill which was approved by the House on Sept. 2. Zinc-bearing ore containing 25 per cent or more of zinc is to be dutiable at 1c. per lb. on its zinc contents. A strenuous effort was made to induce the committee to authorize a duty of 2c., but after careful consideration this request was denied.

In addition the bill provides duties as follows: On zinc oxide and white pigment containing zinc, but not containing lead, dry, 1c. per lb.; ground in oil, 1¾c. per lb.; white sulphide of zinc, 1¼c. per lb.; chloride of zinc and sulphate of zinc, 1c. per lb.

In reporting the bill to the Senate, Senator Watson pointed out that the American zinc-producing industry is in a serious condition. Out of eighty-seven mills, which were operating in the Webb City district of Missouri, only two now are working. In Webb City, he asserted, one-third of the inhabitants have left. In addition, he said, 400,000 tons of zinc ore are piled on Australian docks ready for shipment. Since this ore is a byproduct of lead-silver operation, the producers are willing to take any price they can get for it. He also pointed to the menace of Mexican production, which may increase rapidly if conditions in that country should permit.

Personal

A. W. AMBROSE of the U. S. Bureau of Mines has been appointed superintendent of the petroleum experiment station of the Bureau at Bartlesville, Okla. He succeeds W. P. DYKEMA, who has resigned in order to be able to devote more time to the natural gas investigations of the Bureau.

R. L. COMSTOCK, formerly of the Brown Co., Berlin, N. H., is now with the Warner Chemical Co., Cartaret, N. J., as plant chemist.

HARRIS D. HINELINE resigned as research engineer with the Westinghouse Electric & Manufacturing Co. to become a member of the faculty of the Science School of the Carnegie Institute of Technology, department of chemistry, Pittsburgh, Pa.

GEORGE P. HORN, formerly of the Service Bureau of the Portland Cement Co.'s Pittsburgh office, is now chief chemist of the Security Cement & Lime Co. He will have charge of the laboratories at the cement plant at Security, Md., and the lime plant at Berkeley, W. Va.

Dean DAVID MCKINLEY will remain in office as president of the University of Illinois, as recently confirmed by the board of trustees.

EDWARD MALLINCKRODT, president of the Mallinckrodt Chemical Co. of St. Louis, has been elected to the board of directors of the Laclede Gas Light Co. of St. Louis.

C. G. RICE of Boston has been elected president of the U. S. Smelting, Refining & Mining Co. to fill the vacancy caused by the death of William G. Sharp last July.

E. KILBURN SCOTT, consulting engineer, of New York, has recently been in Chicago and Western points on professional business. Mr. Scott has been called to Washington to testify before the Senate Committee on Agriculture relative to the arc process of nitrogen fixation.

FERDINAND L. SNYDER, formerly assistant engineer of the Baltimore Copper Smelting & Rolling Co., has resigned to accept the position of efficiency and assistant plant engineer, Portsmouth Cotton Oil Refining Co., Portsmouth, Va.

Dr. E. C. SULLIVAN has been elected vice-president of the Corning Glass Works, Corning, N. Y.

CYRIL S. TAYLOR has resigned from the Bureau of Standards, Washington, to go in the research department of the Aluminum Company of America at its laboratories at New Kensignton, Pa. Mr. Taylor expects to begin his work in the new position some time during June.

F. G. TRYON, who just has been appointed head of the mineral fuels division of the U. S. Geological Survey, is widely known among chemists from the fact that he was in charge of chemical and explosives statistics for the Council of National Defense during the early portion of the war, and later was in charge of statistics of chemicals, fuels and explosives for the General Staff.

Obituary

ROBERT TREAT SPICE, professor emeritus of chemistry at Cooper Union, who died April 8 in his seventy-fourth year at his home in Bloomfield, N. J., had been a teacher in various private and public institutions of New York and Brooklyn for more than forty years.

Chemistry and physics were his specialties. These subjects were taught by him at the Girls' Evening High School, in Court St., Brooklyn, in the late '70s; next at the Brooklyn Polytechnic Institute, and from 1888 to 1900 at the Girls' High School in Brooklyn. While occupying this last position he taught classes in chemistry and astromony in the evenings at Cooper Union. In 1900 he gave up all other work to devote himself day and evening to Cooper Union as professor of chemistry, retaining this post until obliged by failing health to retire in 1914.

THEODORE N. VAIL, head of the American Telephone & Telegraph Co., died April 16, in his seventy-fifth year. Bell invented the telephone, Vail made it a business success. Bell set out to prove and did prove that men could talk over wires, and still the obstinate world continued to poke fun at "Bell's toy." Vail caught and held a vision of this "toy" put to worldwide commercial use. He was the man of vast business capacity in the story of the telephone. He strung the first long-distance line, and the same world that had sneered at Bell called it "Vail's folly." He lived to direct the second largest corporation in the world, with 19,000,000 miles of wire.

Funeral services were held on Sunday, April 18, and at 11 o'clock, Eastern standard time, on that day the service on every Bell telephone throughout the country was suspended for one minute in tribute to the man who was for so many years the master of the organization.

Current Market Reports

The Non-Ferrous Metal Market

New York, April 19, 1920.—Prices of copper, tin, lead and antimony are unchanged. The decline of silver continues, the present quotation being $1.19½ per oz., against $1.26 last week. There has been a general stiffening in the price of scrap metals.

	Cents per Lb
Copper, electrolytic	19.25
Aluminum, 98 to 99 per cent	32@33
Antimony, wholesale lots	11.25
Nickel, ordinary	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	62.25
Lead, New York, spot	9.00
Lead, E. St. Louis, spot	8.70
Zinc, spot, New York	8.80
Zinc, spot, E. St. Louis	8.30

OTHER METALS

Silver	oz.	$1.19½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.50
Cobalt	lb.	1.50
Magnesium (f. o. b. Niagara Falls)	lb.	1.60
Platinum	oz.	142.00
Iridium	oz.	250.00
Palladium	oz.	142.00
Mercury	75 lb.	103.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	29.50
Copper sheets, cold rolled (over 14 oz.)	31.50
Copper bottoms	38.00
Copper rods	26.75
High brass wire and sheets	25.25
High brass rods	23.75
Low brass wire and sheets	27.25
Low brass rods	28.00
Brazed brass tubing	37.00
Brazed bronze tubing	41.75
Seamless copper tubing	32.00
Seamless bronze tubing	34.50
Seamless high brass tubing	30.50

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	22.50 @24.50
Aluminum, sheet scrap	23.50 @24.50
Copper, heavy machinery comp	15.50 @16.00
Copper, heavy and wire	15.75 @16.00
Copper, light and bottoms	14.25 @14.75
Copper, heavy cut and crucible	16.25 @17.25
Brass, heavy	10.00 @10.25
Brass, light	8.50 @ 9.00
No. 1 clean brass turnings	10.00 @10.25
No. 1 comp. turnings	13.75 @14.25
Lead, tea	5.25 @ 5.40
Lead, heavy	7.00 @ 7.50
Zinc, scrap	4.25 @ 4.50

The Iron and Steel Market

Pittsburgh, Pa., April 16, 1920.

The iron and steel market became stagnant, except for the booking of some contracts for finished products, when the rail strike occurred and rendered a large part of the industry idle. Last Monday most of the blast furnaces tributary to the Connellsville coke region were banked, as is was certain no coke would get through, and day by day more capacity went down, as the byproduct ovens had no stocks of coal to speak of. The territory most affected was the Youngstown district, the Calumet (Chicago and Gary) and the Pittsburgh districts coming next. The East was less affected and the South very little. At this writing the strike seems to be waning rapidly, but it will be several days before there is anything like a free movement of coal and coke. It may be estimated roughly that nearly half the industry loses somewhat more than a week's output.

Such loss is a very serious one from the viewpoint of the moment, but the more natural viewpoint is the one at long range, for the whole problem of the iron and steel trade since the first of the year has been the question of recovery from the acute shortage of material that existed at the end of the old year. When could the industry "catch up"? Up to the time of the rail strike, as indicated in previous reports, production had been proving much larger than had been predicted in many quarters. The market, the one that still exists, was made on the basis of the shortage and the expectations of its being difficult if not impossible to produce enough to relieve the shortage. If production had been proving 10 per cent greater than expected, then the loss of output caused by the rail strike, say 2 per cent of a half year's production, may be compared with that 10 per cent, appearing insignificant by comparison. It may be said, of course, that the rail strike is only one trouble, and that there may be others, but the rail strike was more or less expected. During the steel strike in the late months of last year it was commonly remarked in the trade that just about the time the iron and steel industry got through with its own strike it would probably be crippled by a rail strike, this conforming to the familiar dictum that life is just one thing after another. Iron and steel production really has quite a bright prospect now.

The lethargy that manifested itself in the iron and steel markets upon the appearance of the rail strike was rather greater than would be expected in normal conditions, seeing that no one expected the strike to last any length of time, and the episode rather suggests that the market has a natural tendency to take things easy at this time. If consumers of pig iron and steel products have any particularly sanguine views as to the future, they have no opportunity to profit by making purchases, since it is obvious that prices are already as high as they are likely to go, and there is no incentive to buy except to insure the receipts of supplies. In the case of purchases from independent steel producers a premium over the real market basis has to be paid, for the independents are all asking more than the Steel Corporation or Industrial Board prices, and it has become moderately well established that the market is essentially taking those prices as a basis and other prices as containing delivery premiums above that basis. As to Steel Corporation sales, they continue to be made in greater volume than the shipments, the corporation customers showing no hesitancy.

Steel Corporation Tonnages

The March increase in the Steel Corporation's unfilled obligations was indeed greater than the February increase, the increases having been 389,994 tons in March, 216,640 tons in February and 1,020,075 tons in January. The increase in bookings from February to March was greater than appears in these figures, seeing that shipments in February were about 90 per cent of capacity and shipments in March about 96 per cent, so that there was a greater drain in the latter month on the order books. The March bookings become the more impressive when it is noted that the corporation's sheet and tin plate subsidiary was not selling to any extent, being booked up for the present half year and not having opened its books for regular second half business.

Last Tuesday, as expected, the American Sheet & Tin Plate Co. opened its order books for second half contracts with manufacturing consumers and third quarter contracts with jobbers, prices being those formerly adhered to, as contained in the Industrial Board iron and steel price schedule which became effective March 21, 1919. The pig-iron producers departed upward from that schedule as soon as they got the chance, late last year. Many of the independent producers departed downward from the schedule in April and May of last year, while afterward all independents got above the schedule. The Steel Corporation alone adhered strictly to the schedule right along, making no departures in either direction.

The prices set for sheets and tin plates are: Blue annealed sheets, 10 gage, \$3.55; black sheets, 28 gage, \$4.35; galvanized sheets, 28 gage, \$5.70; tin plates, 100-lb. weight, \$7 per base box. A base box is 31,360 sq.in., tin plate being sold by area, not by weight.

The independent tin plate manufacturers will, in general, adhere to the \$7 price in transacting business with regular customers, but probably more tonnage will be saved to sell on the prompt market, at the premiums expected to rule, than was the case when contracts were made for the present half year.

The independent sheet manufacturers, on the other hand, appear to be paying absolutely no attention to the action of the leading interest. They have all been quoting and receiving prices above the Industrial Board schedule, the prices varying according to time of delivery, and ranging from half a cent to several cents a pound above the Steel Corporation basis. An independent mill could hardly expect to sell its product for the entire second half of the year at a premium, while if all or a large number dropped to the Steel Corporation level the buyers might become suspicious. The present situation exists, and with it the independents can hardly do otherwise than adhere to their prices and sell what they can for such deliveries as the trade will take. Apart from this, there is the awkward fact with many of the independents that they must buy sheet bars and cannot get them except at much above the Industrial Board price of \$42. As high as \$90 has been paid recently, and regular tonnages could hardly be bought for third quarter except at \$60 to \$75. The sheet mill could not absorb such a difference.

Pig Iron

The pig iron market continues stagnant and no appearance is presented of prices tending to depart from the level previously quoted as the market: Bessemer, \$42; basic, \$41.50; foundry, \$42, f.o.b. valley furnaces, freight to Pittsburgh being \$1.40.

Ferro-Alloys

While complete information is lacking, it is a fair guess that production and consumption of ferro-alloys is about equally affected by the rail strike. The market is stagnant and is quotable about as follows: Prompt domestic ferromanganese, \$200@250 delivered; second half, \$180@200; electrolytic ferrosilicon, delivered, \$80 for 50 per cent and \$140 for 75 per cent; bessemer ferrosilicon, f.o.b. furnaces at New Straitsville and Jackson, Ohio, \$59.50 for 10 per cent, \$62.80 for 11 per cent and \$66.10 for 12 per cent.

Chemical and Allied Industrial Markets

New York, April 19, 1920.

The condition of these markets is probably as bad as it has ever been in the history of the trade. Demand on the part of users continues brisk, with no material at hand to dispose of these orders. Spot offerings are all nominal, as nearly all lines are bare and producers are unable to ship any goods in to relieve this condition. The combination of freight embargo and the truckmen's strike has effectually paralyzed any activity during the past week. It is reported that in some cases producers have large quantities of material waiting shipment but owing to the car or steel drum shortage they are unable to move it from their plants. A real shortage of raw materials in some markets is responsible for the present high prices, as demonstrated by listings of the coal-tar intermediates in general, which are practically nominal throughout.

PRINCIPAL PRICE CHANGES

	Today	Last Week	Last Month	Last Year
Formaldehyde	$0.60-$0.80	$0.60-$0.80	$0.90-$1.00	$0.22-$0.22¼
Dimenthylaniline	nominal	0.95-1.50	0.95-1.50	0.55-0.60
Epsom salts	3.60-4.25	3.60-4.25	3.60-3.75	2.25-2.35
Sodium bichromate	0.35-0.40	0.35-0.40	0.35-0.36	0.09-0.10
Turpentine	$2.50	$2.30	$2.20	0.77-0.78

Prices of chemicals in general remain unchanged, as there is very little trading being done at prices that would be a fair indication of the real market quotation. The spot market on some of the more active items is practically bare and whatever offerings are made are at extreme prices. *Alum*, potash lump, came up slightly under heavier demand and at the close of the week was listed at 8@8¾c. per lb. *Aqua ammonia*, 26 degree, drums, is listed at 8½@10¾c. per lb., against 7½@10½c. of last week. This rise has been caused by increased inquiry and a tightening of supplies. *Bleaching powder* remains in the same position, with very little material available. Nominal quotations of $4@$4.25 per cwt. still hold, while prices as high as $5 have been heard for spot material. *Cream of tartar* is firmer at 56@58c. for contract and 59@61c. per lb. for less than car lots. *Sodium bicarbonate* came up to $2.45@$2.60 per cwt., with foreign inquiry heavier than during the previous week. *Sodium nitrite* is back to normal, supplies on hand being fairly heavy; 22@26c. per lb. is now the average selling price on this item. *Glauber's salt* is in very poor condition and there is very little material being offered at $1.50@$1.70 per cwt. and as high as $2 is being asked for spot material.

Coal-Tar Products

The coal-tar products market presents the same general aspect as was previously reported. There have been very few material changes on the list, high water prices being generally sustained by the steady demand and shortage of supplies. *Napthaline crushed* is firmer at 8@9½c. per lb., *flake* holds at 9@10c., while *ball* grade, under considerable pressure, is listed at 10½@11c. per lb. *Phthalic anhydride* remained firm at 65@75c. per lb., with one concern making the price and holding it down to undersell the smaller competitors.

Naval Stores

The naval stores market is practically at a standstill, as there is scarcely any grade of rosin available and no turpentine at all to be had. Nominal quotation of $2.49 per gal. for turpentine has been received, but there is no material changing hands at this or any other price. This is principally due to the fact that no shipments from Savannah can be made because of the shipping strike along the coast.

Vegetable Oils

Activity in vegetable oils has fallen off slightly during the past week. Prices have not been materially affected, the listings in general holding firm at former levels. *Cocoanut oil*, Ceylon grade, is listed at 18½@19c. per lb. and *cottonseed*, crude, is firm at 17½@18c. per lb. while *linseed* is slightly easier than it was last week at $1.84, raw, car lots, $1.77 for raw, tank cars, and $1.87 per gal. for boiled, car lots.

Chicago, April 14, 1920.

A complete absence of spectacular features marks the chemical trade in Chicago for the past several weeks. Firmness characterizes prices in all lines, except in vegetable oils, and their weakness, which has previously been noted, has become accentuated. A decrease in the availability of acids is also noticed which apparently indicates higher prices to come. Alkali products are still at a premium and advances continue to be registered.

One element that contributes largely to shortage of local stocks is that of transportation. There is great scarcity of metal drums in which to pack materials, and tank cars also are in very poor supply. This renders the transfer of chemicals from the plant to the user difficult. Added to that, the current railroad men's strike has complicated matters. Plants whose products are sold up months ahead find themselves with an accumulation of manufactured product which they are unable to ship, and jobbers and consumers, even though fully covered by supply contracts, are unable to get goods. At present the rail strike seems to have spent the greater portion of its strength so far as the Chicago district is concerned.

Heavy Chemicals

With the exception of alkali products this market shows no changes of moment. *Formaldehyde*, while about as scarce as was the case when $1 a pound was being asked, is now going for 61@65c., with the latter figure probably most accurately reflecting the market. All *alcohols* remain in heavy demand at top prices. *Wood alcohol* is now higher than ever before, transactions being noted at $2.80@$3 for 97 per cent. *Ethyl alcohol*, 190 proof, is quoted nominally at $5.35@$5.50, practically none being available, and *denatured* can be purchased at a prevailing price of $1.

Caustic soda is very hard to get. A peculiar feature is that while the price in cars, f.o.b. works, is now 6¼c. on solid and 6½c. on granulated, what spot stocks are available may be purchased at from ½c. to ¾c. lower. The reason is that dealers' stocks have been acquired on contract at considerably lower figures. Needless to say, only small quantities are available. *Soda ash* is daily becoming harder to get, as the plants are all far behind on orders. Current quotation of 3¼@3¾c. should be considered nominal. *Bleach*, suffering from a shortage of containers, is up on market to 4c. per lb. in carloads. Actual transactions in spots have gone as high as 4½c. *Sal soda*, though still scarce, has receded somewhat in price. Current quotations are $1.35 per cwt. from factory, $1.50 per cwt. from Chicago stocks.

Sodium nitrite shows a further return to normal, 25c. per lb. being the ruling quotation. Much interest is being shown in glycerine and a slight increase, to 25c. per lb., for c.p. grade is noted. *Blue vitriol* is also in good demand and has recently advanced ½c., to 8¼@8½c. Acid stocks are getting low; however, no price changes of importance have occurred. Owing to increased costs, *acetic* is up slightly, 28 per cent commercial being quoted at $4.37½ per cwt. *Nitric* has also advanced a half cent, today's price on 38 deg. being 9½c.

Coal-Tar Products

Shortages of containers and transportation facilities tend to keep supply limited and prices strong. *Benzol*, with demand insistent, is up to 30c. in cars, while *toluol* still holds at the old price of 28c. *Aniline oil* remains at a premium, recently advancing to 36c. per lb. The *salts* are also advanced to 34c. and both oil and salts are very hard to obtain for immediate delivery. *Naphtha* is also scarce, and it is difficult to name definite quotations. Holders of stock are asking 26c. and even higher.

Vegetable Oils

An almost total lack of buying strength has caused further slump in vegetable oils. Supply is plentiful in all lines. *Cocoanut oil* is today being quoted at 16½c. on the Coast in either tanks or barrels, and in barrels the local price is 17¾c. *Corn oil*, with no buyers, is offered from stock at 15½c. and in cars, f.o.b. works, at 14¾@14¾c. *Cottonseed oil* shares the general depression, the crude being worth 15¾c. while prime summer yellow in sellers' tanks is offered at 16½c. No quotation is available on refined, deodorized, in barrels. *Soya bean oil* shows the greatest weakness of the entire list, with Coast quotation in tanks 13½c. and local stocks in barrels finding no takers at 15c.

Flotation Oils—Naval Stores

Entry of the new crop has so far influenced *turpentine* but slightly, ruling price now being $2.40 in bbl., $2.22@$2.25 in cars. It is freely admitted that this price is too high, and a break may be anticipated at any time. This market will probably see two-dollar turps in a short time. Flotation oils do not seem to know where to stop in the price climb; .933 pure steam distilled pine oil is up to $1.85 today and the destructively distilled grade is only 10c. cheaper, at $1.75. *Pine tar oil* and *rosin*, remaining in good demand, show no fluctuation.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.		$0.60 – $0.65
Acetone	lb.	$0.13 – $0.15	.16 – .18
Acid, acetic, 28 per cent	cwt.	3.50 – 4.00	4.25 – 4.50
Acetic, 56 per cent	cwt.	8.00 – 8.25	8.25 – 8.50
Acetic, glacial, 99½ per cent. carboy	cwt.	12.00 – 14.00	16.50 – 17.50
Boric, crystals	lb.	.14½ – .15½	.15½ – .16½
Boric, powder	lb.	.14½ – .15	.15 – .16
Citric	lb.	.85 – .85	1.17 – 1.18
Hydrochloric	lb.	.08 –	.09 – .10
Hydrofluoric, 52 per cent	lb.	.12 – .12½	.14 –
Lactic, 44 per cent tech	lb.	.11 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.04½ – .05	.05½ – .07
Molybdic, C. P	lb.	–	4.25 – 5.00
Nitric, 40 deg	lb.	.07 – .07¼	.07½ – .08½
Nitric, 42 deg	lb.	.07½ – .08	.08½ – .09½
Oxalic, crystals	lb.	.44 – .45	.46 – .48
Phosphoric, Ortho, 50 per cent solution	lb.	.24 –	–
Picric	lb.	.33 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.50 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	16.00 – 18.00	–
Sulphuric, 60 deg., drums	ton	–	–
Sulphuric, 66 deg., tank cars	ton	22.00 – 25.00	–
Sulphuric, 66 deg., drums	ton	32.00 – 33.00	–
Sulphuric, 66 deg., carboys	ton	34.00 – 35.00	–
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 – 30.00	32.00 –
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 – 30.00	34.00 –
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 –
Tannic, U. S. P	lb.	–	1.35 – 1.45
Tannic (tech.)	lb.	–	.00 – .80
Tartaric, crystals	lb.	–	.69 – .74
Tungstic, per lb. of WO	lb.	–	1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 – 5.50	6.00 – 7.00
Alcohol, Methyl (nominal)	gal.	2.35 – 3.50	–
Alcohol, denatured, 188 proof (nominal)	gal.	–	1.00 – 1.05
Alcohol, denatured, 190 proof (nominal)	gal.	–	.98 – 1.02
Alum, ammonia lump	lb.	.04 – .05	.05½ – .06
Alum, potash lump	lb.	.08 – .08½	.09 – .09½
Alum, chrome lump	lb.	.15 – .16	.18 – .20
Aluminum sulphate, commercial	lb.	.01½ – .02	.02½ – .03½
Aluminum sulphate, iron free	lb.	.02½ – .03	.03¼ – .03¾
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08½ – .10¾	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.33 – .35	.35 – .37
Ammonium carbonate, powder	lb.	.16 – .16½	.17 – .17½
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.15½ – .16½	.17 – .18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 – .13½	.14 – .14½
Ammonium nitrate	lb.	.10 – .12	–
Ammonium sulphate	lb.	.07 – .08	.08½ –
Amylacetate	gal.	–	3.65 – 3.75
Arsenic, oxide, lumps (white arsenic)	lb.	–	.10½ – .11
Arsenic, sulphide, powdered (red arsenic)	lb.	.23 – .24	–
Barium chloride (nominal)	ton	125.00 – 135.00	170.00 – 180.00
Barium dioxide (peroxide)	lb.	.23 – .27	.28 – .30
Barium nitrate	lb.	.17 – .19	.20 – .22
Barium sulphate (precip.) (blanc fixe)	lb.	.03 – .03½	.05½ – .06
Bleaching powder (see calcium hypochlorite)		–	–
Blue vitriol (see copper sulphate)		–	–
Borax (see sodium borate)		–	–
Brimstone (see sulphur, roll)		–	–
Bromine	lb.	.85 – .90	–
Calcium acetate	cwt.	2.00 – 2.05	2.10 –
Calcium carbide	lb.	.05 – .06	.06½ – .07
Calcium chloride, fused, lump	ton	22.00 – 25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	4.00 – 4.25	4.35 – 5.00
Calcium peroxide	lb.	–	1.50 – 1.70
Calcium phosphate, monobasic	lb.	–	.75 – .80
Calcium sulphate, pure	lb.	–	.25 – .30
Carbon bisulphide	lb.	.07 – .08	.09 – .10
Carbon tetrachloride, drums	lb.	.11 – .11½	.12 – .15½
Carbonyl chloride (phosgene)	lb.	–	.80 – 1.05
Caustic potash (see potassium hydroxide)		–	–
Caustic soda (see sodium hydroxide)		–	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .07	.08 – .09
Chloroform	lb.	.29 – .30	.31 – .32
Cobalt oxide	lb.	–	2.00 – 2.05
Copperas (see iron sulphate)		–	–
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.	–	.65 – .70
Copper sulphate, crystals	lb.	.08¼ – .09	.09 – .09¼
Cream of tartar (see potassium bitartrate)		–	–
Epsom salt (see magnesium sulphate)		–	–
Formaldehyde, 40 per cent (nominal)	lb.	.38 – .40	.60 – .80
Glauber's salt (see sodium sulphate)		–	–
Glycerine	lb.	–	.24½ – .26
Iodine, resublimed	lb.	–	4.10 – 4.30
Iron oxide, red	lb.	–	.03 – .20
Iron sulphate (copperas)	cwt.	1.50 – 1.75	1.80 – 2.00
Lead acetate, normal	lb.	.14 – .14½	.15 – .18
Lead arsenate (paste)	lb.	.11 – .12	.13 – .17
Lead nitrate, crystals	lb.	–	.90 – 1.00
Litharge	lb.	.14 – .15	.15½ – .16
Lithium carbonate	lb.	–	1.50 –
Magnesium carbonate, technical	lb.	–	.13 – .14½
Magnesium sulphate, U. S. P.	100 lb.	3.40 – 3.55	3.60 – 4.25
Magnesium sulphate, commercial	100 lb.	3.00 – 3.10	3.10 – 3.25
Nickel salt, double	lb.	.14 –	.15 –
Nickel salt, single	lb.	.16 – .17	.17½ –
Phosgene (see carbonyl chloride)		–	–
Phosphorus, red	lb.	–	.60 – .65
Phosphorus, yellow	lb.	–	.35 – .37
Potassium bichromate	lb.	.36 – .37	.38 – .42
Potassium bitartrate (cream of Tartar)	lb.	.56 – .58	.59 – .61
Potassium bromide, granular	lb.	–	.50 – .65
Potassium carbonate, U. S. P.	lb.	.60 –	.65 – .70
Potassium carbonate, crude	lb.	.21 – .25	.28 – .30
Potassium chlorate, crystals	lb.	.15 – .16	.21 –
Potassium hydroxide (caustic potash)	lb.	.28 – .29	.30 – .35
Potassium iodide	lb.	–	3.35 – 3.60
Potassium nitrate	lb.	.19 –	.21 –
Potassium permanganate	lb.	–	$0.65 – $0.95
Potassium prussiate, red	lb.	1.00 – 1.05	1.10 – 1.2
Potassium prussiate, yellow	lb.	.34 – .36	.38 – .41
Potassium sulphate	ton	$225.00 – 240.00	–
Rochelle salts (see sodium potas. tartrate)		–	–
Salammoniac (see ammonium chloride)		–	–
Sal soda (see sodium carbonate)		–	–
Salt cake	ton	22.00 – 26.00	–
Silver cyanide (nominal)	oz.	–	1.25 –
Silver nitrate (nominal)	oz.	–	.77 – .82½
Soda ash, light	100 lb.	2.75 –	3.50 – 3.60
Soda ash, dense	100 lb.	2.90 – 3.25	3.55 – 3.65
Sodium acetate	lb.	.06½ – .07	.07 – .08
Sodium bicarbonate	100 lb.	2.45 – 2.60	2.75 – 3.00
Sodium bichromate	lb.	.33 – .34	.35 – .40
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 10.00
Sodium bisulphite Powered	lb.	.05½ – .06½	.07 – .07½
Sodium borate (borax)	lb.	.08½ – .08¾	.09 – .09½
Sodium carbonate (sal soda)	100 lb.	1.60 – 1.80	1.80 – 2.00
Sodium chlorate	lb.	.10 –	.12 – .14
Sodium cyanide, 96-98 per cent	lb.	.24 – .25	.26 – .27
Sodium fluoride	lb.	.14 –	.15 – .16
Sodium hydroxide (caustic soda)	100 lb.	4.50 – 5.50	6.00 – 6.50
Sodium hyposulphite	lb.	–	.03 – .04
Sodium molybdate	lb.	2.50 –	3.25¼ –
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.26 – .27	.33 – .35
Sodium peroxide, powdered	lb.	–	.30 – .32
Sodium phosphate, dibasic	lb.	.03½ – .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	.39 – .40	.40 – .41
Sodium prussiate, yellow	lb.	.23 – .25	.30 – .40
Sodium silicate, solution (40 deg.)	lb.	.01½ – .02	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.04 – .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.50 – 1.70	1.75 – 2.00
Sodium sulphide, crystal, 60–62 per cent (conc)	lb.	.07 – .07½	.08 – .08½
Sodium sulphite, crystals	lb.	.03½ –	.04 – .06
Strontium nitrate, crystals	lb.	.25 –	.28 –
Sulphur chloride	lb.	.05¼ –	.06 –
Sulphur, crude	ton	22.00 –	–
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	3.35 –	3.40 – 3.65
Sulphur, roll (brimstone)	100 lb.	3.20 –	3.30 – 3.40
Tin bichloride (stannous)	lb.	.42½ –	.46 – .50
Tin oxide	lb.	.50 – .60	.65 –
Zinc carbonate, precipitate	lb.	–	.19 – .20
Zinc chloride, gran.	lb.	.13 –	.13½ – .15
Zinc cyanide	lb.	.49 –	.50 – .60
Zinc dust	lb.	.11½ – .12½	.13 – .15
Zinc oxide, U. S. P	lb.	–	.19 – .21
Zinc sulphate	lb.	.03½ – .03¾	.04 – .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00 — $1.10
Alpha naphthol, refined	lb.	1.40 — 1.60
Alpha naphthylamine	lb.	.40 — .50
Aniline oil, drums extra	lb.	.34 — .45
Aniline salts	lb.	.42 — .48
Anthracine, 80% in drums (100 lb.)	lb.	.90 — 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 — 2.10
Benzidine, base	lb.	1.25 — 1.35
Benzidine, sulphate	lb.	1.20 — 1.25
Benzoic acid, U.S.P.	lb.	.90 — 1.10
Benzoate of soda, U.S.P.	lb.	.80 — 1.00
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27 — .36
Benzol, 90%, in drums (100 lb.)	gal.	.25 — .31
Benzyl chloride, 95-97%, refined	lb.	.35 — .40
Benzyl chloride, tech	lb.	.25 — .35
Beta naphthol benzoate	lb.	.50 — .65
Beta naphthol, sublimed	lb.	.70 — .90
Beta naphthol, tech	lb.	.45 — .55
Beta naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal.	.95 — 1.10
Cresylic acid, 95-97%, dark, in drums	gal.	.85 — 1.00
Cresylic acid, 50%, first quality, drums	gal.	.60 — .70
Dichlorbenzol	lb.	.08 — .10
Diethylaniline	lb.	1.40 — 1.50
Dimethylaniline (nominal)	lb.	–
Dinitrobenzol	lb.	.30 — .37
Dinitrochlorbenzol	lb.	.25 — .30
Dinitronaphthaline	lb.	.45 — .55
Dinitrophenol	lb.	.34 — .36
Dinitrotoluol	lb.	.40 — .45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine (nominal)	lb.	.55 — .65
H-acid (nominal)	lb.	1.90 — 2.00
Metaphenylenediamine	lb.	1.15 — 1.80
Monochlorbenzol	lb.	.10 — .12
Monoethylaniline	lb.	1.71 — 1.85
Naphthaline crushed, in bbls. (250 lb.)	lb.	.08 — .09
Naphthaline, flake	lb.	.09 — .10
Naphthaline, balls	lb.	.11 — .11
Naphthionic acid, crude	lb.	.70 — .85
Nitrobenzol	lb.	.14 — .19
Nitro-naphthaline	lb.	.41 — .50
Nitro-toluol	lb.	.20 — .30
Ortho-amidophenol	lb.	3.75 — 4.25
Ortho-dichlorbenzol	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.80 — 1.25
Ortho-nitro-toluol	lb.	.25 — .40
Ortho-toluidine	lb.	.25 — .45
Para-amidophenol, base	lb.	2.50 — 3.50
Para-amidophenol, HCl	lb.	2.50 — 3.25
Para-dichlorbenzol	lb.	.08 — .12
Paranitraniline	lb.	1.00 — 1.35
Para-nitro-toluol	lb.	1.25 — 1.50
Paraphenylenediamine	lb.	2.60 — 3.00
Paratoluidine	lb.	2.00 — 2.50
Phthalic anhydride	lb.	.65 — .75
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.11 — .25
Pyridin	gal.	2.00 — 2.50
Resorcin, technical	lb.	4.25 — 4.50
Resorcin, pure	lb.	6.25 — 6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50 — .52
Salicylic acid, U. S. P.	lb.	.55 — .60
[illegible]	lb.	.90 — 1.00

Solvent naphtha, water-white, in drums, 100 gal.	gal.	$0.25	—	$0.31
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19	—	.24
Sulphanilic acid, crude	lb.	.25	—	.30
Toluidine	lb.	1.70	—	2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.28	—	.....
Toluol, in drums	gal.	.29	—	.32
Xylidine, drums, 100 gal.	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal.	gal.	.37	—	.45
Xylol, commercial, in tank cars	gal.	.23	—	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.38	—	$0.39
Beeswax, refined, light	lb.	.40	—	.41
Beeswax, white pure	lb.	.63	—	.68
Carnauba, No. 1, (nominal)	lb.	.80	—	.88
Carnauba, No. 2, regular (nominal)	lb.	.60	—	.70
Carnauba, No. 3, North Country (nominal) †	lb.	.43	—	.45
Japan	lb.	.19	—	.20
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.....	—	.10
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.....	—	.11
Paraffine waxes, refined, 118-120 m.p.	lb.	.....	—	.10½
Paraffine waxes, refined, 128-130 m.p.	lb.	.11	—	.11½
Paraffine waxes, refined, 133-135 m.p.	lb.	.12	—	.13
Paraffine waxes, refined, 135-137 m.p.	lb.	.13½	—	.14
Stearic acid, single pressed	lb.	.26	—	.27
Stearic acid, double pressed	lb.	.32	—	.29
Stearic acid, triple pressed	lb.	.32	—	.33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.65
Pine oil, pure, dest. dist.	gal.	.....
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.42
Pine tar oil, crude, sp. gr. 1.025-1.07, tank cars f.o.b. Jacksonville, Fla.	gal.	.38
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$17.95	—$19.50	
Rosin E-I	280 lb.	19.75	— 20.00	
Rosin K-N	280 lb.	20.25	— 21.95	
Rosin W. G.-W. W.	280 lb.	22.00	— 24.00	
Wood rosin, bbl.	280 lb.	15.50	— 18.50	
Spirits of turpentine	gal.	.....	— 2.49	
Wood turpentine, steam dist.	gal.	2.35	— 2.40	
Wood turpentine, dest. dist.	gal.	.....	— 2.00	
Pine tar pitch, bbl.	200 lb.	8.40	— 8.50	
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	— 15.00	
Retort tar, bbl.	500 lb.	15.00	— 15.50	
Rosin oil, first run	gal.	.92	— .95	
Rosin oil, second run	gal.	.94	— .97	
Rosin oil, third run	gal.	1.10	— 1.15	
Rosin oil, fourth run	gal.	1.17	— 1.18	

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.40½	—	$0.42
Upriver coarse	lb.	.30½	—	.32
Upriver caucho ball	lb.	.32½	—	.33
Plantation—First latex crepe	lb.	.47½	—	.48½
Ribbed smoked sheets	lb.	.47	—	.48
Brown crepe, thin, clean	lb.	.45	—	.....
Amber crepe No. 1	lb.	.46	—	.47

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.19	—	$0.20
Castor oil, AA, in bbls.	lb.	.20	—	.23
China wood oil, in bbls.	lb.	.24½	—	.25½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.18½	—	.19
Cocoanut oil, Cochin grade, in bbls. (nominal)	lb.	.19½	—	.20
Corn oil, crude, in bbls.	lb.	.17½	—	.18
Cottonseed oil, crude (f.o.b. mill)	lb.	.17½	—	.18
Cottonseed oil, summer yellow	lb.	.18½	—	.19
Cottonseed oil, winter yellow	lb.	.21	—	.23
Linseed oil, raw, car lots	gal.	1.84	—	.....
Linseed oil, raw, tank cars	gal.	1.77	—	.....
Linseed oil, boiled, car lots	gal.	1.87	—	.....
Olive oil, commercial	gal.	2.50	—	3.00
Palm, Lagos	lb.	.16	—	.16½
Palm, bright red	lb.	.15½	—	.17½
Palm, Niger	lb.	.15	—	.17½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.20½	—	.22
Peanut oil, refined, in bbls.	lb.	.27	—	.28
Rapeseed oil, refined in bbls.	gal.	1.64	—	1.70
Rapeseed oil, blown, in bbls.	gal.	1.64	—	1.68
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.19	—	.23
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.15½	—	.16

FISH

Winter pressed Menhaden	gal.	$1.17	—	$1.18
Yellow bleached Menhaden	gal.	1.20	—	1.22
White bleached Menhaden	gal.	1.23	—	1.24
Blown Menhaden	gal.	1.30	—	1.35

† (See New York market letter)

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$38.00	—$40.00	
Barytes, off color	ton	20.00	— 25.00	
Blanc fixe, dry	lb.	.04½	— .05½	
Blanc fixe, pulp	ton	30.00	— 50.00	
Casein	lb.	.....	—	
Chalk, English, extra light	lb.	.05	— .07	
Chalk, English, light	lb.	.04½	— .06	
Chalk, English, dense	lb.	.04	— .05	
China clay (Kaolin), imported, lump	ton	25.00	— 35.00	
China clay (Kaolin), imported, powdered	ton	30.00	— 60.00	
China clay (Kaolin), domestic, lump	ton	10.00	— 20.00	
China clay (Kaolin), domestic, powdered	ton	25.00	— 40.00	
Feldspar (nominal)	ton	13.50	— 18.00	
*Fluor spar, acid grade, lump, f.o.b. mines	net ton	30.00	— 45.00	
*Fluor spar, acid grade, ground, f.o.b. mines	net ton	55.00	— 65.00	
Fuller's earth, domestic, powdered	ton	25.00	— 30.00	
Fuller's earth, imported, powdered	ton	35.00	— 40.00	
Graphite, crucible, 85% carbon content	lb.	.....	— .07½	
Graphite, crucible, 86% carbon content	lb.	.....	— .08	
Graphite, crucible, 87% carbon content	lb.	.....	— .08½	
Graphite, crucible, 88% carbon content	lb.	.....	— .09	
Graphite, crucible, 89% carbon content	lb.	.....	— .09½	
Graphite, crucible, 90% carbon content	lb.	.....	— .10	
Graphite, crucible, 91% carbon content	lb.	.....	— .10½	
Graphite, crucible, 92% carbon content	lb.	.....	— .11	
Graphite, crucible, plus 92%	lb.	.....	— .12½	
Pumice stone, imported	lb.	.03	— .06	
Pumice stone, domestic	lb.	.02½	—	
Shellac, orange, fine nominal	lb.	1.45	—	
Shellac, orange, superfine	lb.	1.60	— 1.65	
Shellac, A. C. garnet	lb.	1.30	— 1.35	
Soapstone	ton	15.00	— 25.00	
Talc, domestic	ton	20.00	— 60.00	
Talc, imported	ton	60.00	— 70.00	

*Nominal

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	75-80 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	45-50 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	40-45 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-85 at Chester, Penn.
Silica brick	1,000	50-55 at Mt. Union, Penn.

Ferro-Alloys

All Prices f.o.b. works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—$250.00	
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.20	— .21	
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.21	— .22	
Ferro-manganese, 70-80% Mn.	gross ton	180.00	— 240.00	
Spiegeleisen, 16-20% Mn	gross ton	60.00	— 65.00	
Ferro-molybdenum, per lb. of Mo.	lb.	2.25	— 2.75	
Ferro-silicon, 50%	gross ton	80.00	— 90.00	
Ferro-silicon, 75%	gross ton	150.00	— 200.00	
Ferro-silicon, 10-15%	gross ton	60.00	— 65.00	
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	.90	— 1.10	
Ferro-uranium, 35-50% of U	lb.	7.00	—	
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	6.50	— 7.50	

Ores and Semi-finished Products

All Prices f. o. b. Mines

Chrome ore, 35-40%, Cr_2O_3	unit	$0.70	—	$0.85
Chrome ore, 48% and over	unit	1.00	—	1.25
*Coke, foundry, f.o.b. ovens	net ton	7.00	—	.....
*Coke, furnace, f.o.b. ovens	net ton	6.00	—	.....
Petroleum coke, refinery, Atlantic seaboard	net ton	.....	—	14.00
Fluor spar, gravel, f.o.b. mines	net ton	25.00	—	30.00
Manganese ore, 45% Mn and over	unit	.75	—	.85
Manganese ore, chemical (MnO_2)	gross ton	80.00	—	90.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00	—	10.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.50	—	7.50
Uranium oxide, 96%	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	6.00	—	.....
Pyrites, foreign, lump	unit	.17	—	.....
Pyrites, foreign, fine	unit	.17	—	.....
Pyrites, domestic, fine	unit	.16	—	.17½
Ilmenite, 52% TiO_2	lb.	.02	—	.....
Rutile, 95% TiO_2	lb.	.11	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00
Zircon, washed, iron free	lb.	.10	—	.....
Monazite, per unit of ThO_2	unit	42.00	—	.....

*Government prices.

Structural Steel

Mill, Pittsburgh

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.65
Rivets, structural, ½-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ½-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.85
Sheets, No. 10 blue annealed	100 lb.	4.00
Sheets, No. 28 galvanized	100 lb.	6.20

For painted corrugated sheets add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage for galvanized corrugated sheets, add 15c., all gages.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM — The Dixie Brass & Fdry. Co., 6th Ave. North, between 12th and 13th Sts., plans to build an addition to its present plant. Estimated cost, $50,000.

California

GLENDALE—The city plans to construct a complete sewer system, including a sewage disposal plant, etc. Bonds for this project will be voted upon. Estimated cost, $500,000. J. C. Sherer, city clk. Olmsted & Gillilen, 1112 Hollingsworth St., engrs.

Colorado

GREELEY—The Industrial Sugar Co. plans to build a beet sugar factory on a site half way between Johnstown and Milliken, southwest of here. Estimated cost, $1,000,000.

Connecticut

BRIDGEPORT—The Bryant Electric Co., 1421 State St., plans to build a 4-story, 50 x 140-ft. manufacturing plant addition on State St. Estimated cost, $125,000.

BRIDGEPORT—The Eastern Malleable Iron Co., Naugatuck, has awarded the contract for the construction of a 1-story, 80 x 180-ft. foundry on South Ave., to the T. J. Pardy Constr. Co., 1484 Seaview Ave. Estimated cost, $45,000.

NEW BRITAIN — Landers, Frary & Clark, Commercial St., have awarded the contract for the construction of a 6-story factory for the manufacture of cutlery and electric specialties, to the Torrington Bldg. Co., 197 Water St., Torrington.

Florida

DELAND—The DeLand Gas Improvement Co. has received bids for the construction of a gas plant, here. A. J. Parkhurt, gen. mgr.

FERNANDINA—The Florida Phosphate Terminal Co. is constructing a building, here. The plant will be able to load several 6,000-ton ships in two days. Drying equipment, etc., will be installed in same. Estimated cost, $500,000. Charles E. Waddell, Asheville, N. C., engr.

Illinois

CHESTERFIELD—The Bd. Educ. will soon award the contract for the construction of a 2-story, 44 x 86-ft. high school. Chemical equipment will be installed in same. Estimated cost, $40,000. Deal & Ginzel, Lincoln, archts.

CHICAGO—The Arabol Mfg. Co., 200 North Jefferson St., has awarded the contract for the construction of a liquid glue plant on 64th Ave. and 16th St., to R. C. Wieboldt. The company is building the first unit of the plant. Estimated cost, $750,000.

CHICAGO—The Englewood Ice & Storage Co. plans to build an artificial ice plant at Wallace and West 69th Sts. Plant will have a daily capacity of 200 tons. Estimated cost, $200,000.

CHICAGO—The Essenkay Products Co., 222 West Superior St., has purchased a site on Wentworth Ave. and 83rd St. and plans to construct a tire filler plant on same. Estimated cost, $200,000.

CHICAGO—The Kosmos Ice Co. plans to construct an artificial ice plant at Halsted and 58th Sts. Plant will nave a daily capacity of 100 tons. Estimated cost, $170,000.

CHICAGO—Paul F. Olsen, archt., will soon award the contract for the construction of a foundry for the Home Stove Wks., 2606 West 18th St.

CHICAGO—The Western Electric Co., Inc., 500 South Clinton St., is building a group of factory buildings at the Hawthorne Wks. Estimated cost, $3,500,000.

Indiana

FORT WAYNE—John H. and Wilson C. Ely, archts., Firemans Trust Bldg., Newark, N. J., will receive bids until April 24 for the construction of a 2-story bulb factory here, for the General Electric Co.

Iowa

ALBIA—The city will soon award the contract for the construction of a sewage disposal plant, etc. C. C. Atchison, city clk.

CEDAR FALLS—The Bd. Educ. will receive bids until May 15 for the furnishing of mechanical equipment for four school buildings. Chemical laboratories will be installed in same. Estimated cost, $1,400,000. Rugh & Zalesky, 601 Security Bldg., engrs.

HAWARDEN—The Independent School Dist. will soon award the contract for the construction of a high school, here. A chemical and physical laboratory will be installed in same. G. L. Lockhart, 391 Endicott Bldg., St. Paul, Minn., archt.

MAYNARD—The Maynard Consolidated School Dist. will receive bids until April 27 for the construction of a 2-story, 96 x 144-ft. consolidated school, here. A chemical laboratory will be installed in same. Estimated cost, $150,000. Netcott & Netcott, 517-519 Black Bldg., Waterloo, archts.

REINBECK—The Bd. Educ. plans to build a 2-story, 110 x 146-ft. high school, here. A chemical laboratory will be installed in same. Estimated cost, $225,000. Netcott & Netcott, 517-519 Black Bldg., Waterloo, archts.

SIOUX CITY—The Purity Biological Laboratories, manufacturers of vaccines and anti-hog cholera serums, 311 Nebraska St., plan to construct laboratories here. The first wing of the proposed plant will cost $150,000. Estimated cost of entire plant, $500,000. W. J. Kennedy, pres.

Louisiana

SHREVEPORT—The city is having plans prepared for altering the filter plant, etc. Chester & Fleming, 1111 Union Bank Bldg., Pittsburgh, Pa., engrs.

Maryland

BALTIMORE — The Natl. Steel Rolling Co., Keyser Bldg., plans to build a plant. Estimated cost, $100,000.

Massachusetts

PITTSFIELD—The General Electric Co., Morningside, plans to build a 1-story, 100 x 400-ft. manufacturing building. Estimated cost, $250,000.

SOUTH ATTLEBORO — The Home Bleach & Dye Wks., Branch St., Pawtucket, has awarded the contract for the construction of a 3-story, 75 x 90-ft. dye house, to J. J. Prindiville Co., 59 Concord St., Framingham. Estimated cost, $60,000.

WOLLASTON (Boston P. O.)—The Howard Chemical Co., c/o E. R. Simpson, archt., 176 Federal St., Boston, will soon award the contract for the construction of a 3-story, 55 x 120-ft. chemical manufacturing plant on Old Colony Ave. Estimated cost, $50,000.

Michigan

MARSHALL—The Flint Fdry. Co. plans to build a 1-story, 70 x 200-ft. and 80 x 118-ft. foundry buildings. Foundry equipment will be installed in same. Estimated cost, $75,000. C. E. Boyd, mgr.

PONTIAC—C. W. Ham, city clk., City Hall, will receive bids until May 17 for the construction of a 10,000,000-gal. filtration plant and a filtered water reservoir, including a wash water tank, coagulating basin, etc.

Minnesota

ELLSWORTH—E. A. Meester, village recdr., will soon award the contract for the construction of sanitary sewers, disposal works, including a disposal tank, sludge bed, etc. Estimated cost, $40,000. Druar & Smith, Globe Bldg., St. Paul, engrs. Noted March 17.

HANCOCK—The Bd. Educ. will receive bids until April 28 for the construction of a 2-story, 60 x 110-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $100,000. A. A. Roberts, clk. S. Jaconson, 403 Endicott Bldg., St. Paul, archt.

HIBBING—T. J. Godfrey, clk., will receive bids until April 27 for the construction of a 2-story, 62 x 400-ft. high school on Mesaba St., for the Bd. Educ. A chemical laboratory will be installed in same. Estimated cost, $500,000. W. T. Bray, Torrey Bldg., Duluth, archt. and engr.

KEEWATIN—School Dist. 9, Itasca Co., has awarded the contract for the construction of a 2-story, 160 x 174 ft. high school, to J. M. and W. A. Elliott, Exch. Bldg., Minneapolis, at $354,715. A complete chemical laboratory will be installed in same.

LAKE BENTON—E. W. Kimball, village recdr., will receive bids until April 26 for the installation of 1 sludge bed, 2 ejectors, and 1 treatment bed, etc. Estimated cost, $30,000. Bradley Eng. Servc., St. Cloud, engr.

MOORHEAD—Independent School Dist. 2 received bid for installing laboratory fittings in the proposed school, here, from the Kewaunee Mfg. Co., $9,222.

NASHWAUK—School Dist. 9, Itasca Co. has awarded the contract for the construction of a 2-story, 160 x 174-ft. high school to A. C. Thomas Guthrie Constr. Co., Guardian Life Bldg., St. Paul, at $365,360. Complete laboratory equipment will be installed in same.

New Hampshire

MANCHESTER—The city is having plans prepared for the construction of a practical art high school. A chemical and physical laboratory will be installed in same. Estimated cost, $300,000.

New Jersey

EAST ORANGE—The Simms Magneto Co., 279 Halsey St., has awarded the contract for the construction of a 2-story, 154 x 167-ft. factory on North Arlington Ave., to the Amer. Concrete Steel Co., Essex Bldg., Newark. Estimated cost, $385,000.

EGG HARBOR CITY—The city is having plans prepared for the construction of a sewage disposal plant, etc. Estimated cost, from $40,000 to $50,000. Remington & Vosbury, 6th and Market Sts., Camden, engrs.

HADDONFIELD — The city, Borough Hall, will receive bids until May 10 for the construction of a sewage disposal plant with clarification tank and sprinkler filters. Estimated cost, from $45,000 to $50,000. Remington & Vosbury, 6th and Market Sts., Camden, engrs.

WOODBURY HEIGHTS—The city is having plans prepared for the construction of a sewage disposal plant, etc. Estimated cost, from $40,000 to $50,000. Remington & Vosbury, 6th and Market Sts., engrs.

New York

BUFFALO—The Bering Steel Fdry. Co., Morris St., plans to build a 1 and 2-story steel foundry addition to present plant. Estimated cost, $20,000.

BUFFALO—The Standard Oil Co., Atlas Wks., 1103 Elk St., plans to construct a 1-story chilling and pressing building. Estimated cost, $30,000.

NEWARK—The H. A. Inman Co. plans to build a 1-story, 60 x 60-ft. foundry bldg. adjacent to present plant, here. Estimated cost, from $12,000 to $15,000.

OGDENSBURG — The Cooper's Brass Wks., Inc., plans to purchase the distillery plant of J. P. Wiser & Sons Co., Ltd., Prescott, Ont., and by means of alterations and additions convert same into a brass manufacturing plant. Estimated cost, from $30,000 to $40,000. Address R. J. Donohue.

ROCHESTER—The Eastman Kodak Co., 333 State St., plans to build a 33 x 36 x 14-ft. dry kiln; cost, $5,200, and a 32 x 162 x 31-ft. fabricating plant at Kodak Park; cost, $10,000.

ROCHESTER—The Langslow Fowler Co., 216 Jay St., plans to build a 1-story, 45 x 122-ft. drying kiln on Smith St. Estimated cost, $35,000.

North Carolina

CHERRYVILLE—The city has awarded the contract for the construction of 3 sewage disposal plants, to Tucker & Laxton, Inc., Charlotte, at $13,693. Noted Feb. 11.

North Dakota

BISMARCK—The city is having plans prepared for the construction of a new water treatment, filter, water softening and chlorine treatment plants. Estimated cost, $225,000. T. R. Atkinson, city engr.

McVILLE—The Town Council will soon award the contract for furnishing a concrete septic tank, etc. Estimated cost $28,000. Atkinson & Hall, Devils Lake, engrs.

Ohio

CLEVELAND—The Bd. Educ., East 6th St. and Rockwell Ave., plans to build a 1-story high school addition on West 93rd St. and Willard Ave. Chemical laboratories will be installed in same. Estimated cost, $350,000. F. G. Hogan, Dir. W. R. McCormack, East 6th St. and Rockwell Ave., archt.

CLEVELAND—The Cuyahoga Fdry. Co., c/o Frank Hronek, archt., 3608 East 131st St., has awarded the contract for the construction of a 1-story, 100 x 210-ft. foundry on East 71st St. and the Belt Line, to Frank Vejsicki, 3492 Washington Park Blvd. Estimated cost, $100,000.

COLUMBUS—The Climax Rubber Co., 21 West Gay St., is having plans prepared for the construction of a 3-story, 200 x 200-ft. tire and tube factory on West Goodale St. Estimated cost, $200,000. W. F. Blair, archt.

EAST LIVERPOOL — The Davidson Porcelain Co. plans to build a porcelain plant.

ELYRIA—The Lakeshore Rubber Co., 734 Natl. City Bldg., Cleveland, is having plans prepared for the construction of a 3-story, 80 x 240-ft. rubber factory along the New York Central R. R. tracks, here. Estimated cost, $125,000. Akron Eng. Co., Akron, archt. and engr.

FREMONT—The Fremont Fdry. Co. has awarded the contract for the construction of a 1-story, 60 x 220-ft. foundry, to the Fort Pitt Bridge Wks., House Bldg., Pittsburg, Pa. Estimated cost, $100,000.

YOUNGSTOWN—The city is having plans prepared for the construction of a 2-story, 60 x 150-ft. municipal hospital. A chemical laboratory will be installed in same. Estimated cost, $250,000. C. F. Owsley, Mahoning Bank Bldg., archt.

YOUNGSTOWN—C. L. Cliff, clk., R. F. D. 3, will receive bids until May 14 for the construction of a 2-story township school on Churchill St., for the Liberty Township School Bd. A chemical laboratory will be installed in same. Miller & Son, 408 Dollar Bank Bldg., archts.

Oklahoma

MANGUM—The Bd. Educ. will soon award the contract for the construction of a 3-story high school. A chemical and physical laboratory will be installed in same. Estimated cost, $130,000. Hawk & Parr, 501 Security Bldg., Oklahoma City, archts.

Pennsylvania

ELKINS PARK — The School Dir. of Cheltenham Township will receive bids until May 3 for the construction of a 4-story, 75 x 225-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $400,000. H. C. Wise, 925 Chestnut St., Philadelphia, archt.

LANCASTER—The City Council plans an election in May to vote upon $825,000 bond issue for various city improvements, including a sewage disposal plant, etc.

PHILADELPHIA — The Luithlen Dye Wks., J. and Estaugh Sts., plan to build a manufacturing plant addition, etc. Chemical equipment for making dyes will be installed in same. W. Steele & Sons Co., 16th and Arch Sts., archts. and engrs.

PHILADELPHIA—The H. A. May Fdry. Co., Eastwick and 61st Sts., will have plans prepared for the construction of foundry buildings on Walnut and 30th Sts. Foundry equipment will be installed in same. Estimated cost, $100,000. Peuckert & Wunder, 310 Chestnut St., archts. and engrs.

PHILADELPHIA—The Orlando Dyeing Co. has awarded the contract for the construction of a 2-story, 95 x 104-ft. factory on Rorer and Schiller Sts., to A. Crompton & Bros., 4614 Oakland St. Chemical equipment for making dyes will be installed in same. Estimated cost, $62,000.

Rhode Island

PAWTUCKET—The Phillips Insulated Wire Co., Freeman St., has awarded the contract for the construction of a 1-story, 45 x 85-ft. manufacturing plant addition on Winthrop Ave., to Willmorth Mackillop Co., Inc., Freeman St. Estimated cost, $15,000.

Texas

McKINNEY—The Sunlite Co. plans to build a 1-story factory for the manufacture of auto lenses, near here. Estimated cost, $150,000. E. R. Brackett, engr.

PORT NECHES—The Magnolia Petroleum Co., 723 23rd St., Galveston, is having plans prepared for the construction of the first unit of an oil refinery, to have a capacity of 50,000 bbl. per day. Estimated cost, $200,000. John Sealy, pres. G. D. Anderson, Beaumont, engr.

Utah

BINGHAM (Bingham Canyon P. O.)—The Utah Consolidated Mining Co. plans to build a mill to concentrate copper ores by flotation with a capacity of 1,000 tons. The company is in the market for flotation machinery. Estimated cost, $75,000.

Vermont

ST. JOHNSBURY — The Cary Maple Sugar Co. has awarded the contract for the construction of a 2- and 4-story, 54 x 200-ft. factory, to the H. P. Cummings Constr. Co., Fidelity Bldg., Portland, Me. Estimated cost, $125,000. Noted Jan. 21.

Virginia

CULPEPER—The town has awarded the contract for the construction of a waterworks system, to Diehl & Vance, archts. and consult. engrs., Virginia Carolina Bldg., Norfolk. Contract for the construction of small filter plant including coagulating basin, etc., will be sublet.

Wisconsin

BURLINGTON—The Burlington Brass Wks. will build a 1-story, 100 x 140-ft. foundry. Work will be done by day labor. Noted March 23.

MILWAUKEE—The Natl. Brake & Electric Co., Belleview Place, is having plans prepared for the construction of a 1-story, 160 x 180-ft. addition to its foundry. Estimated cost, $150,000. H. J. Esser, Camp Bldg., archt. and engr.

ROBERTS—The Bd. Educ. is having plans prepared for the construction of an addition to the high school, here. A small chemical laboratory will probably be installed in same. Estimated cost, $50,000. Alfred H. Wheeler, 410 Globe Bldg., St. Paul, Minn., archt.

SHEBOYGAN FALLS—C. S. Weisse Co., c/o L. A. Weisse, had plans prepared for the construction of a 4-and 6-story, 60 x 250-ft. tannery on Buffalo St. Estimated cost, from $100,000 to $150,000.

VIROQUA—Edward J. Older, city clk., will receive bids until April 29 for the construction of 2 sewage disposal plants consisting of tanks, sprinkling filters, etc.

Ontario

KITCHENER—The Long Tanning Co., Francis St., has awarded the general contract for the construction of a 3-story tannery to Casper Braum, King and Water Sts. Estimated cost, $150,000.

TORONTO—The Canadian Natl. Carbon Co., 265 Adelaide St., W., and the Prest-o-Lite Co., of Canada, Ltd., 120 Elm St., are having plans prepared for the construction of a 2- and 3-story, 80 x 400-ft. and a 2-story, 80 x 400-ft. factory buildings at Hillcrest Park. Equipment for making dry cells, batteries, acetylene, etc., will be installed in same. Estimated cost, $450,000.

TORONTO—The Y.M.C.A., 21 McGill St., and the Dominion Council, 604 Jarvis St., plan to construct a 4-story Y.M.C.A. building. Chlorinating and violet ray equipment for the swimming tank will be installed in same. Estimated cost, $650,000.

Quebec

CHELSEA—The Royal Securities Corp., Ltd., 164 St. James St., Montreal, plans to build a pulp and paper mill on the banks of the Gatineau River, near here. Estimated cost, $1,000,000.

Saskatchewan

SASKATOON—The North Star Oil Refining Co. will soon receive bids for the construction of a refinery. A warehouse and tanks will be constructed in connection with same.

MOOSE JAW—The Western Oil Co., Ltd., will soon receive bids for the construction of a large oil refining plant.

Coming Meetings and Events

THE AMERICAN ASSOCIATION OF ENGINEERS will hold its sixth annual convention at the Planters Hotel in St. Louis, May 10 and 11.

THE AMERICAN ELECTROPLATERS' SOCIETY will hold its eighth annual convention in Rochester, June 30 to July 3. Headquarters will be at the Seneca Hotel.

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its semi-annual meeting in Montreal, June 21 and 22; Ottawa, June 23; Shawinigan, June 24 and 25, and La Tuque, June 26.

THE AMERICAN IRON AND STEEL INSTITUTE will hold its spring meeting May 28 at the Hotel Commodore, New York City.

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its annual meeting at Asbury Park, N. J., June 22 to 25.

THE AMERICAN WELDING SOCIETY will hold its annual meeting at the Engineering Societies Building, 33 West 39th St., New York, on Thursday, April 22.

THE AMERICAN ZINC INSTITUTE will hold its spring meeting May 10 and 11 at the Congress Hotel, Chicago, Ill.

THE CHAMBER OF COMMERCE OF THE U. S. announces that its eighth annual meeting will be held at Atlantic City, April 27 to 29, the subject of which will be "Increased Production."

THE CHEMICAL SOCIETY OF THE COLLEGE OF THE CITY OF NEW YORK is pleased to announce the following lectures for the spring semester of 1920 to be delivered in the Doremus Lecture Theater: "Water Supply and Drainage in Water Cantonments," Wednesday, April 21, at 4 p.m., Prof. D. D. Jackson, administrative head, department of chemical engineering, Columbia University (*Lantern*); "Modern Coke and Gas Manufacture" (Koppers process), Thursday, April 29, at 4 p.m., E. L. Crowe (*Lantern and cinema*); "Chemical Naval Warfare," Friday, May 7, at 4 p.m., Prof. James Kendall, professor of chemistry at Columbia University; "Fighting Fire—Firefoam," Friday, May 14, at 4 p.m., F. A. Epps, chief engineer, the Foamite Firefoam Co. (*Experimental, cinema and lantern.*)

THE INSTITUTE OF METALS DIVISION OF THE A.I.M.E., will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

THE IRON AND STEEL INSTITUTE (London) will hold its annual meeting May 6 and 7, 1920, at the House of the Institute of Civil Engineers, Great George St., London, S. W. 1. The retiring president, Eugene Schneider, will induct into the chair Dr. J. E. Stead, the president-elect.

THE MINE INSPECTORS' INSTITUTE OF AMERICA will hold a meeting at Cleveland, Ohio, July 13, 14 and 15.

THE MINING SOCIETY OF NOVA SCOTIA has planned a meeting for May 4 and 5 which will be held in Glace Bay.

THE NATIONAL ACADEMY OF SCIENCES will hold a meeting at the Smithsonian Institution and the new museum, Washington, D. C., April 26 to 28, at which there will be discussions and reports on timely subjects of general interest. All scientific sessions will be open to the public.

THE SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

THE NATIONAL FERTILIZER ASSOCIATION will hold its twenty-seventh annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 21.

THE NATIONAL FOREIGN TRADE CONVENTION will be held in San Francisco, May 12 to 15. Chinese delegates have chartered the S. S. Ecuador for transportation to this conference.

THE NATIONAL SAFETY COUNCIL, Engineering Section, will hold its spring conference in the Engineering Societies Building, New York City, on April 27.

THE NEW JERSEY CHEMICAL SOCIETY plans the following: Saturday, April 24, 2:30 p.m., visit to the plant of the Raritan Copper Co., Perth Amboy, N. J.; Monday evening, May 10, regular meeting; Saturday afternoon and evening, June 5, at Rutgers College, New Brunswick, N. J., regular meeting and ladies' day.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION will hold its twenty-seventh annual meeting June 29 to July 3, at the University of Michigan, Ann Arbor, Mich.